Appendices

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Ten appendices support the *I-70 Mountain Corridor PEIS Alternatives Development and Screening Technical Report*:

- **Appendix A** describes the transportation management alternative elements considered for the *I-70 Mountain Corridor PEIS*. It presents an overview of Corridor problems (consistent with the purpose and need, as described in **Chapter 1** of the PEIS), provides an overview of comparable North American case studies and best practices, and describes and assesses specific transportation management strategies for the Corridor. The report was prepared by URBANTRANS in 2003 and remains a valid assessment of Corridor transportation management strategies. The case studies and ideas presented continue to be relevant strategies that could be implemented in the Corridor. Because the I-70 highway has not undergone any major changes, CDOT has not implemented any of the strategies outlined in the report, and the report assesses a broad range of strategies, the 2003 report has not been updated but remains valid.
- Appendix B describes the transit alternative elements considered for the *I-70 Mountain Corridor PEIS*. It provides the introduction to the transit families for Rubber Tire Transit and Fixed Guideway Transit. It discusses the characteristics of each technology type and provides background to the capabilities of the technologies to operate in the Corridor. It was prepared in 2000 when the transit alternative elements were first being considered. Although old, the report describes the initial constraints of the technologies and is contemporary to the screening processes and decisions ongoing during this timeframe.
- Appendix C provides more detailed data for the transit alternative elements considered for the I-70 Mountain Corridor PEIS. It presents train performance modeling results from the RAILSIM model and assesses the model results with the criteria for Level 2 screening. In addition, this report provides a conceptual operating plan for both Rubber Tire and Fixed Guideway Transit. The report was prepared in 2001 and is contemporary to the screening decisions that were occurring during that timeframe. As such, the 2001 information documents the decisions that occurred early in the process and remains valid.
- Appendix D discusses limitations of Fixed Guideway Transit systems to operating on steep mountain grades. It describes theoretical design issues as well as empirical examples of systems worldwide. It does not assess technologies that have developed or been implemented since the report was prepared. The PEIS notes updates in system technologies and acknowledges that technological advances will need to be revisited in Tier 2 processes. The information presented in Appendix D is old and would need to be updated in Tier 2 studies but is helpful to provide context to decisions being made during the screening process.
- Appendix E provides a summary of the Level 1 and Level 2 screening processes and presents refined data about transit performance to support Level 3 screening. It also presents rationale for initial footprints of transit alternative elements. Although the alternatives advanced for discussion in the PEIS continued to be refined and, in this way the information presented in Appendix E is out of date, the report provides documentation about how alternatives were developed and the decision making that supported the advancement of alternatives to the PEIS. The PEIS contains current discussion of the alternative footprints.
- **Appendix F** presents results of Level 2 screening for transit and highway alternatives. In addition to describing the screening criteria and evaluation results, it presents a summary of environmental impacts for each alternative. The environmental impact information has been updated in the PEIS but the discussion of the screening process remains valid documentation of the decision making processes that resulted in the range of alternatives that are evaluated in the PEIS.
- **Appendix G** discusses air service characteristics and operational inventory of airports in and serving the Corridor. The information supports the evaluation and screening of aviation improvements as a family of alternatives that could be considered to relieve I-70 highway

Alternatives Development and Screening Technical Report

congestion. Although the report was prepared early in the PEIS process, the information remains valid because neither vehicular nor air travel conditions in the Corridor have changed enough to change the assessment of aviation alternatives. Additionally, the aviation elements fall well short of meeting I-70 highway needs, which reinforces the decision not to update data or reconsider aviation elements.

- Appendix H presents an assessment of how many automobile trips could be diverted by aviation improvements. The conclusion that an estimated 50 to 100 trips per day might be diverted by improvements to west slope airports reinforces the conclusions in Appendix G that aviation improvements would have little effect on I-70 congestion. As with Appendix G, updating the information is not worthwhile even if the trips doubled, tripled, or more, the aviation elements would still have little to no effect on I-70 highway congestion.
- **Appendix I** discusses the development, evaluation, and screening of alternate routes to the I-70 highway. The report was prepared in 2000. Because no major changes to the I-70 highway or the alternate routes evaluated have occurred since that time, the analyses remains valid, especially for comparison of alternatives at a Tier 1 level.
- **Appendix J** discusses the Level 1 screening process. The report was prepared in 2000 and represents documentation of decisions made during that timeframe.

Appendix A URBANTRANS Transportation Management Alternatives

January 2003

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Transportation Management Alternatives

I-70 Mountain Corridor

Draft Environmental Impact Statement

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January 2003



Overview

Transportation Management focuses on reducing Corridor congestion and improving overall mobility on the existing I-70 facility. This alternative includes an integrated package of Transportation Management strategies that maximize the operational efficiency and person-moving capacity of the Corridor by better balancing the <u>demand</u> for travel on I-70 with the <u>capacity</u> of I-70 to handle travel demand. Many of these strategies rely heavily on public-private partnerships to achieve desired results.

Transportation Management includes the coordinated implementation of transportation demand management (TDM), transportation system management (TSM), and intelligent transportation system (ITS) strategies. As an introduction, the following brief definitions are provided:

- **Transportation Demand Management (TDM).** TDM is designed to most efficiently use existing transportation facilities by managing the actual "demand" placed on these facilities. Using integrated strategies that maximize available travel-mode choices, increase vehicle occupancy, reduce travel distances, and shift peak-period demand to non-peak periods, TDM programs extend the useful life of transportation facilities and enhance mobility options.
- **Transportation System Management (TSM).** TSM measures involve operational improvements to existing transportation facilities that maximize their person-moving capacity, reduce the severity and duration of temporary (for example, crash and weather) delays, and improve safety.
- **Intelligent Transportation Systems (ITS).** ITS involves the application of advanced technologies and communications to optimize the efficiency of transportation systems. ITS applications are often an integrated support element of both TDM and TSM strategies.

The Transportation Management strategies summarized in this section include TDM, TSM, and ITS strategies as part of an integrated package. Transportation Management can be implemented as a standalone alternative or integrated as a complement to other "build" alternatives.

I-70 Transportation Management Existing and Forecast Conditions Assessment Introduction

Transportation Management strategies attempt to reduce the severity and duration of congestion and to enhance overall mobility by improving the balance between the <u>demand</u> for travel on I-70 with the <u>capacity</u> of I-70 to handle travel demand. These strategies recognize that both travel demand and facility capacity can vary under a variety of circumstances.

Transportation Management strategies generally exclude extensive infrastructure investments aimed at expanding roadway capacity. Instead, these strategies focus on:

- Management of travel demand to reduce the severity and duration of circumstances where travel demand exceeds existing roadway capacity. Modifications to travel demand can include adjustments to travel time (by time-of-day and/or day-of-week), travel route, trip distance (through changes in trip origins and destinations), and vehicle occupancy.
- 2. Management of existing Corridor capacity to address locations where relatively minor improvements to the roadway network or highway operations will help address temporary or long-term capacity bottlenecks. Temporary bottlenecks include those caused by incidents, weather, and construction factors.

Development and implementation of Transportation Management strategies along Colorado's I-70 Mountain Corridor must be tailored to fit the unique recreationbased nature of trip-making in the Corridor. Although the national base of experience in Transportation Management is more extensive for urbanized areas, recreation-centered corridors can be particularly appropriate for Transportation Management strategies because they often have highly predictable travel patterns, significantly increased travel demand during specific peak-periods, and relatively concentrated travel destinations. Additionally, corridors with a high volume of recreational trips often have high environmental amenity values tied to both the travel route and the trip destination, increasing the value of transportation strategies with lower environmental impacts.

The coordinated management of both demand and capacity fosters greater efficiency from existing transportation facilities, maximizing their <u>overall</u> personmoving and goods-moving capacity. Well-designed, well-coordinated Transportation Management strategies can provide win-win solutions to transportation challenges in recreation-centered corridors by improving the overall visitor experience, enhancing economic vitality, and reducing (or delaying) the need for major transportation infrastructure investments with potentially high economic and environmental costs.

Challenges for Transportation Management on I-70

The following factors present challenges to the development of Transportation Management strategies in the I-70 Mountain Corridor.

- Lack of a coordinating organization for I-70 "functional area." The I-70 Mountain Corridor represents a single functional area. Defined by common geographic characteristics and tourism-related economic generators and united by I-70 as a major transportation connector, residents and visitors live, work, and play throughout the entire I-70 Mountain Corridor, from west Denver to Glenwood Springs. This common "functional area" includes five counties, more than ten municipalities, multiple public and private transit operators, and one regional airport. However, there is no existing organization to coordinate activities that impact transportation across jurisdictions. This is a challenge because the development and implementation of many Transportation Management strategies rely on enhanced coordination between transportation providers and between the public- and private-sector organizations. In many corridors around the country, Transportation Management Associations (TMA) have been created. These associations bring the diverse interests along the corridor together to help implement Transportation Management strategies.
- Transportation Management less proven in recreation-centered corridors. There is significant experience and understanding of Transportation Management strategies within urbanized areas, particularly for commute-trips. There has been less experience with these strategies for recreation trips. Nonetheless, the last few years have seen a surge in interest in and implementation of Transportation Management measures in tourism environments, with the National Park Service leading the charge in parks like Acadia and Yosemite. The development of Transportation Management strategies for the I-70 Corridor is based on a review and analysis of 11 similar corridors throughout North America, from Lake Tahoe to Cape Cod (see Appendix A).
- Currently high average vehicle occupancy. The average number of passengers per vehicle in the I-70 Mountain Corridor today is approximately 2.4, considerably higher than national averages for all trips types but normal for recreation-centered corridors. Incremental increases in average vehicle occupancy (AVO) are often more difficult in areas where AVO rates are already high.

Opportunities for Transportation Management on I-70

The following factors present opportunities for the development of successful Transportation Management strategies in the I-70 Mountain Corridor.

• Strong network of local transit systems and pedestrian-friendly communities. Eagle County Transit, Summit Stage, localities, and ski areas

currently operate successful, and free, transit services in a large percentage of the primary destination areas along the Corridor. Additionally, many of the primary destination communities along the I-70 Corridor feature pedestrianfriendly central areas. These services are a critical element for the success of many Transportation Management strategies, as they provide a background network of transportation infrastructure for those arriving without a vehicle.

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- Distinct and predictable trip types and patterns. Recreation trips along the I-70 Corridor, particularly those originating from the Front Range, are largely distinct (in terms of trip purpose) and predictable (in terms of travel patterns and departure times). Additionally, travel route options are limited, and destinations concentrated. Winter destinations are more concentrated than summer destinations. Compared to the varied and disperse nature of urban commute-trips, trip-making in recreation-centered corridors like I-70 is more focused, which allows more effective targeting of Transportation Management strategies to specific travel markets.
- High value on travel experience among recreation, "choice" trips. The 1999-2000 I-70 User Study found that 63 percent of travelers on I-70 (Winter 2000) made "similar trips" on I-70 once a month or less. For trips taken less frequently, particularly recreation trips (which are typically optional, or "choice" trips), travelers often place a higher value on travel "experience." Other factors such as travel cost and travel time, while still relevant, are often less of a priority than they would be for trips like commute-trips that are undertaken much more frequently. When the travel destination is recreation/enjoyment, transportation to the destination becomes part of the overall experience. As such, there are opportunities for Transportation Management strategies to tailor travel options that stress convenience and enjoyment (even over travel time and travel cost factors).
- **Peak-shifting is already occurring.** Travel patterns along I-70 have already shifted to off-peak hours in response to growing traffic congestion during peak-periods. While this shift in demand provides a degree of congestion relief, these shifts are occurring in response to a "negative" influence: peak-period congestion. There is reason to believe that some trips are eliminated altogether from the I-70 Corridor, which has a detrimental impact on economic vitality for both private- and public-sector interests in the Corridor. There is an opportunity to "control the message" and begin to shift the influential factors from negatives (congestion, difficult driving conditions, etc.) to positives (convenient travel options, off-peak travel incentives, etc.).
- Incremental improvements mitigate/delay the need for investments with high economic and environmental costs. Transportation Management measures target-specific roadway locations and time periods where demand exceeds capacity. As such, to be effective, these strategies do not need to achieve large-scale shifts in corridor-wide travel behavior. Relatively small shifts in demand can "smooth the peak" and improve overall operations and



efficiency. Additionally, even minor shifts in demand (and reductions in temporary delays) can delay the need for major infrastructure investments by getting more out of existing facilities.

Comparable North American Case Studies and Best Practices

The following section provides an overview of best practices from 11 North American case studies researched for this project to establish a context for the development and evaluation of Transportation Management strategies for the I-70 Mountain Corridor. **Appendix A** provides a full description of these case studies.

Case Study Locations

- 1. The Lake Tahoe Region, California/Nevada
 - Various corridors including Nevada State Route 28, California's I-80, California Highway 50
- 2. Whistler-Blackcomb, British Columbia
 - Highway 99
- 3. Cape Cod National Seashore, Massachusetts
 - Route 6
- 4. Florida Keys
 - US 1, from Miami to Key West
- 5. US National Parks
 - Great Smoky National Park Cades Cove Loop
 - Acadia National Park
 - Grand Canyon National Park
 - Zion National Park
 - Yosemite National Park
- 6. Washington State
 - I-405 corridor
- 7. I-93: Salem to Manchester, New Hampshire

Best Practices Overview

Despite the unique geographic features, level of planning efforts and differing political environments, the case study research identified the following specific programmatic and marketing best practices for the implementation of Transportation Management strategies in high recreation-travel corridors:



Programmatic and Institutional Best Practices

- **Regional coordination:** Coordinate with local and public planning agencies (including departments of transportation, parks departments, city and county jurisdictions, metropolitan planning organizations, etc.), businesses (including tourist agencies, resorts, ski resorts, etc.), and residents (including peak-season and year-round residents) when planning Transportation Management strategies.
- **Integration of commute-oriented strategies:** Include commute-oriented employee mobility strategies within the overall tourism-focused Transportation Management plan.
- **Incentives over disincentives:** Focus on incentives over disincentives to increase vehicle occupancy and encourage off-peak travel as a means to maintain or improve the visitor experience for recreational-oriented trips.
- Affordability, convenience, and enjoyment: Make transportation choices easy to use, affordable, and fun for visitors. Non-auto-oriented travel options should be fully integrated into the overall visitor experience.

Marketing and Information Best Practices

The case study research revealed the importance of marketing and information programs to the effectiveness of Transportation Management programs:

- **Information early and often:** Market TDM and Transit programs at every level of the visitor's experience. The visitor should be aware of transportation options from when they start planning their trip to when they arrive. Provide detailed, easy-to-understand information to visitors regarding their travel choices and how to use them.
- **Take advantage of technology and existing information channels:** Use the Internet, tourist and travel agencies, and resort marketing programs to market both recreation and transportation messages.
- **Tailor messages to key target markets:** Include marketing efforts targeted at two distinct visitor audiences: those who arrive car free and those who drive.



Development of Transportation Management Strategies

The following issues are central to the development of all of the alternatives:

- 1. Understand travel market segments and target travel markets with the best ability to solve the problem. While there are a tremendous number of trip types using the I-70 Corridor, Transportation Management strategies designed to address specific transportation problems must (1) target the primary target markets contributing to these problems and (2) design travel options that appeal to these target markets. Program development should be focused, not scattershot. As such, market segmentation research should be a key precursor to the development of travel alternatives and marketing messages. Examples of very general market segments using the I-70 Corridor might include:
 - a. Front Range Winter Day-trippers
 - b. Front Range Winter Overnighters
 - c. Out-of-town Winter Overnighters
 - d. Front Range Summer Day-trippers
 - e. Front Range Summer Overnighters
 - f. Out-of-town Summer Overnighters
 - g. I-70 Employees/Daily Commuters
- 2. Focus on a positive visitor experience. The Transportation Management strategies focus on incentives over disincentives in the design and promotion of recreation-oriented travel choices and non-peak-period travel.
- 3. Capture trips before they enter the I-70 Corridor. Strategies to promote high-occupancy travel options (whether private carpools/vanpools, private shuttles, or public transportation) should capture trips from Colorado's Front Range and Denver International Airport (DIA) before entering the I-70 Corridor. For example, development of park-n-rides for Front Range travelers should occur close to trip origins within the Front Range, rather than along the I-70 Corridor itself. Benefits include maximizing vehicle occupancy on the I-70 Corridor and reducing parking demand at constrained destinations.

Transportation Management Strategies – Description and Assessment

1. Peak-Spreading and Vehicle-Occupancy Incentives

Brief Description: The use of incentives to shift travel demand by time of day and day of week and to increase average vehicle occupancy. Incentives include financial incentives, travel time and convenience incentives, and reward/point program incentives ("frequent flier points").

Consider demand/capacity relationships across all impacted sectors. While travel demand and available roadway capacity on the I-70 Corridor are important to understand, designing an effective Transportation Management program must consider demand/capacity relationship in other business sectors that influence the demand for travel on I-70. Examples include ski lift seats, resort/community parking spaces, lodging beds, restaurant seats, campground spaces, car rental seats, airline seats, etc. A successful Transportation Management program must consider ways that the demand/capacity balance in each of these areas interacts to shape the visitor experience and affect transportation demand on I-70. This analysis will form the basis for win-win public-private partnerships where mutually beneficial overlaps in these demand/capacity ratios exist.

Overview of Strategies:

- 1. "Colorado Mountain Plus" Club
- 2. "Colorado Mountain Plus" Smart Card
- 3. Alternative Recreation Schedule Arrangements
- 4. Travel Industry Partnership Program
- 5. Marketing and Education Campaigns
- 6. "Try Another Way" Challenge Campaigns

Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$250,000 \$500,000
 - Annual: \$300,000 \$1,500,000
- Aggressive Implementation:
 - Start-up: \$500,000 \$750,000
 - Annual: \$1,500,000 \$3,000,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

- Basic Implementation:
 - Summer: 2 4%
 - Winter: 4 8%



- Aggressive Implementation:
 - Summer: 3 6%
 - Winter: 6 10%

Detailed Description of Strategies:

- "Colorado Mountain Plus" Club. Development of an I-70 Mountain Corridor rewards program, based on concepts similar to "frequent flier" rewards programs (called the "Colorado Mountain Plus" program for discussion purposes in this document). A corridor-wide rewards program provides an array of benefits and efficiencies for the implementation of peakspreading and vehicle-occupancy incentives, as well as other Transportation Management strategies. The program would likely be managed by a group like a Transportation Management Association (TMA), such as the proposed "Colorado Mountain Corridor TMA," described in the previous section. Program elements/benefits include:
 - Accrual of reward points and/or direct financial incentives for off-peak travel and increased vehicle occupancy. Managed at either trips origins (for example, airports) or trip destinations (for example, ski resorts).
 - Creates a consolidated "user group" for targeted communications related to transportation issues, incentive programs, travel packages, trip planning, emergency communications, etc. Potentially including:
 - Advanced traveler information services providing traffic updates and recommendations of preferred travel times.
 - Information on lodging discounts available for nights that encourage off-peak travel.
 - Provides advertising "market" for private-sector partners (one of the incentives for private-sector participation) and offers the potential for revenue generation.
 - Program used to integrate several other strategies described in the following sections.
 - Could include development of "organization-based" Colorado Mountain Plus memberships. Special programs and incentives for bulk participation of organized groups. Working through organized groups provides a natural complement for ridesharing promotion, allows leveraging of organizationowned parking spaces along the Front Range (see parking strategies), and provides for targeted marketing and education programs. Groups could include:
 - Companies
 - Youth/school/sports groups
 - College/university/alumni groups
 - Faith groups
 - Out-of-state "ski clubs"

- 2. **"Colorado Mountain Plus" Smart Card.** Development of integrated smart card technology that could serve as a:
 - Lift ticket or ski pass
 - All-providers transit pass (even for "free" services)
 - "Colorado Mountain Plus" debit card for rewards

The development of the Colorado Mountain Plus Smart Card provides tremendous flexibility for the implementation of a Colorado Mountain Plus rewards program, and other incentive-based strategies identified in this plan. As a debit card (using Visa, MasterCard, or other systems), the system would allow the accumulation of credits (in dollars) from incentive programs that could be used for lift tickets, lodging, dining, equipment rentals, campground reservations, car rentals, etc.

- 3. Alternative Recreation Schedule Arrangements. Working closely with ski resorts, recreations areas, lodging groups, and others to explore alternative hours of eligibility for daily and multiday lift tickets, campground reservations, check-in and check-out times, etc., to facilitate off-peak travel patterns. Also includes exploring potential travel packages that combine lodging and activities in an arrangement that allows (or even bundles in) off-peak travel between I-70 destinations and the Front Range or DIA.
- 4. **Travel Industry Partnerships.** Working closely with travel industry stakeholders to explore potential off-peak travel and high-occupancy vehicle incentives, including:
 - <u>Car rental rideshare/non-peak incentive program</u>. Upgrade costs, as well as any administrative costs, partially compensated by free advertising through Colorado Mountain Plus program. Examples:
 - Free comp one-class upgrades for 3+ cars
 - Free upgrade and ski racks for 4+ cars
 - Free upgrade to SUV/Van for 5+ groups, with weekday pickup and return.
 - Free additional day for those returning on Monday.
 - <u>Partnerships with Airlines, Lodging, Restaurant Groups</u>. Targeted to outof-town visitors. Work to bundle transportation between DIA and Mountain Corridor destinations into travel packages. Provide off-peak incentives. Work with lodging groups to provide incentives for stays that do not start/end during peak travel days (for example, free Sunday night stay).
 - <u>Partnership with Travel Agencies</u>. Work with travel agents booking Colorado vacations to bundle transportation into traveling planning services. Provide incentives for those arriving and departing at non-peak times (for example, free lift tickets, car rental days, lodging nights).

Provide incentives for larger groups to book high-capacity vehicles. Provide all those that book with prepackaged travel information and CO Mountain Plus Smart Card.

- 5. **Marketing and Education Programs.** Marketing and education programs are essential to the effectiveness of all Transportation Management programs, including marketing of the "Colorado Mountain Plus" rewards programs, of travel choices and how they work, and of the benefits of "off-peak" travel. Education programs can inform travelers of forecast off-peak "travel opportunities." Integrated marketing of travel destinations and of transportation choices is critical.
- 6. **"Try Another Way" Challenge Campaign.** A key barrier to use of various travel choices is often that travelers have not ever tried other options. This program includes twice a year "try another way" challenge campaigns to encourage travelers to try a different travel option on a specific day or week. This program would be tied to the Colorado Mountain Plus program and include rewards for participation, a significant prize giveaway for each campaign, links to organization-based Colorado Mountain Plus members.

2. Enhanced Traveler Information

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Brief Description: The provision of enhanced traveler information services designed to allow travelers to make "smart" travel mode and travel time (by time-of-day and day-of-week) decisions before departing. Also includes programs to notify travelers of incident- and weather-related delays during their travels and to provide advanced public transportation schedule and routing information.

Provide integrated traveler information before the trip begins. Too often, advanced traveler information programs focus on providing travel information (regarding alternative modes, off-peak travel opportunities, weather/incident delays, etc.) to travelers <u>during</u> their trip. However, unless relevant information is received before departure, opportunities for modifications in travel behavior are more limited (particularly due to the limited nature of alternative routes along I-70). Additionally, traveler information and resort marketing programs should be integrated to maximize opportunities for comprehensive travel planning (integrating choices regarding travel dates, destinations, and duration with choices regarding travel mode and departure time). The "messaging" of resort marketing and travel information should be coordinated and unified.

Overview of Strategies:

- 1. "Colorado Mountain Plus" Website and Personalized Travel Information
- 2. "Colorado Mountain Plus" Travel Information and Operations Center
- 3. Intelligent Public Transportation Systems



Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$100,000 \$250,000
 - Annual: \$100,000 \$400,000
- Aggressive Implementation:

•	Start-up:	\$500,000 - \$5,000,000
•	Annual:	\$400,000 - \$2,500,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

- Basic Implementation:
 - Summer: .25 1%
 - Winter: .5 1.5%
- Aggressive Implementation:
 - Summer: 1 2%
 - Winter: 2 3%

Detailed Description of Strategies:

- 1. "Colorado Mountain Plus" Website and Personalized Travel
 - **Information.** A website that provides users with consolidated trip planning resources (integrating transportation into total trip planning). The website becomes the central resource for advanced traveler information systems, centralizing travel information (including incident/weather updates, congestion reports, etc.) and allowing user personalization (creation of "My Mountain Plus" homepage). Registered users would be able to receive critical travel updates by cell phone or email. Advanced travel planning features would allow integrated planning for transportation connections (along I-70 and at the destination, both public and private), parking information, ski area and other recreation passes, lodging, dining, etc. This site would build on existing services, such as the "Colorado Trip" website developed by CDOT.
- 2. **"Colorado Mountain Plus" Travel Information and Operations Center.** Development of a consolidated travel planning reservation and information center that integrates the services of a "travel agent" and the services of a "mobility manager." Colorado Mountain Plus "customer service agents" would be available to provide trip planning information for all phases of a trip, including information on various I-70 transportation options and information on special off-peak travel packages. Information on using transportation options during the actual visit (for example, how to use the in-town transit services) could also be available.
- 3. **Intelligent Public Transportation Systems.** Investment in advanced vehicle locator and other GPS technologies to improve the availability of real-time information for many of the Corridor's local transit systems. Includes integration of this technology with web and other communications technologies.





Breckenridge Main Street Shuttle

3. Park-n-Rides

Brief Description: Utilization of public, private, and joint-venture park-n-ride / intermodal-transfer facilities to facilitate high-occupancy travel options for trips originating from the Front Range.

Overview of Strategies:

- 1. Front Range Park-n-Ride Joint Development
- 2. Public and Private Park-n-Ride Partnerships

Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$1,000,000 \$2,500,000
 - Annual: \$50,000 \$150,000
- Aggressive Implementation:
 - Start-up: \$3,000,000 \$10,000,000
 - Annual: \$100,000 \$500,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

- Basic Implementation:
 - Summer: .25 .5%
 - Winter: 1 3%
- Aggressive Implementation:
 - Summer: 1 3%
 - Winter: 3-6%

Detailed Description of Strategies:

- 1. Front Range Park-n-Ride Joint Development. Phased development of 5 to 15 Front Range park-n-ride/intermodal-transfer-center projects customized for trips bound for the Mountain Corridor. Pursued as "joint developments" between a potential Colorado Mountain Corridor TMA, public transportation organizations, recreational gear rental companies, ski resorts, gaming companies, restaurateurs, and private transportation providers. Intermodal pickup and drop-off locations would serve private van and shuttle providers, lodging shuttles, gaming shuttles, and public transit vehicles. Facilitates bundling of transportation services with total travel planning ("free shuttle service from the Front Range with any seven night stay"). A portion of the parking capacity can be leased to Front Range public transit providers during off-peak periods. Additionally, incentives based on departure time and vehicle occupancy would be offered at these locations. Incentive programs should be marketed as part of overall trip planning programs and integrated with Colorado Mountain Plus program. Examples could include:
 - Rewards program dollars given by vehicle occupancy
 - Rewards program dollars given for non-peak departures
- 2. **Public and Private Park-n-Ride Partnerships.** Many Front Range parking facilities are used primarily during the work week. This program would facilitate partnerships with organizations that manage parking facilities along the Front Range to promote "private mini-park-n-rides." Partnering organizations could include private parking companies (for example, Lanier Parking), employers, schools, colleges/universities, etc. Partnerships between private parking companies and the Colorado Mountain Plus program could provide free parking and Colorado Mountain Plus Rewards for high-occupancy vehicles or those leaving at non-peak times. With the exception of the private parking facilities, use of the parking at other organizations would be targeted to the groups that typically use these spaces (for example, company employees would use their company's parking spaces on weekends), and ridesharing incentives would be facilitated through Organization-based Colorado Mountain Plus members.

4. Parking Operations and Incentive Plan

Brief Description: Programs to manage existing and future parking facilities at major I-70 Mountain Corridor destinations.

Overview of Strategies:

- 1. Priority Parking Access
- 2. Long-term Management of Parking Capacity



Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$50,000 \$200,000
 - Annual: \$75,000 \$200,000
- Aggressive Implementation:
 - Start-up: \$50,000 \$400,000
 - Annual: \$300,000 \$600,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

- Basic Implementation:
 - Summer: .5 1%
 - Winter: 1 3%
- Aggressive Implementation:
 - Summer: .5 2%
 - Winter: 4 15%

Detailed Description of Strategies:

- 1. **Priority Parking Access.** Coordinated program at ski resort lots, mountain community municipal lots, public recreation area lots, and other managed parking lots along the Mountain Corridor. Incentives include a combination of direct financial incentives, priority access to destinations, and the Colorado Mountain Plus rewards program. Incentives could be tied to both off-peak arrival times and high-occupancy vehicle targets. Examples could include:
 - Access to priority parking areas allowed for arrival before 7:00 AM
 - Access to priority areas provided for 4+ HOVs
 - Rewards points provided for 5+. Examples (illustrative only):
 - \$5 on Colorado Mountain Plus debit card for each person in a car with more than 5 people
 - \$7.50 for each person in 6+ vehicle
 - \$10 for each person in 8+ vehicle
- 2. Long-term Management of Parking Capacity. Coordination between recreation areas and cities/counties in the Corridor to manage the long-term growth of parking capacity at recreation destinations. Continued expansion of unmanaged parking facilities at recreation destination will continue to facilitate growth in overall travel demand along I-70. Reductions in the future growth of parking capacity, coupled with improvements in transportation alternatives to and within Corridor destinations, provide a significant opportunity for reductions in the forecast growth of future travel demand.



5. Bicycle Improvements

Brief Description: Improvements to bicycle connectivity and safety within I-70 Mountain Corridor communities, including investments in bicycle facilities and road-crossings and improvements in bikes-on-transit infrastructure.

Overview of Strategies:

- 1. Municipal Bicycle Planning and Infrastructure
- 2. Bikes-on-Transit Investments

Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$0
 - Annual: \$50,000 \$500,000
- Aggressive Implementation:
 - Start-up: \$0
 - Annual: \$500,000 \$1,000,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

- Basic Implementation:
 - Summer: 0 .5%
 - Winter: 0 .25%
- Aggressive Implementation:
 - Summer: .5 1%
 - Winter: 0 .5%

Detailed Description of Strategies:

- 1. **Municipal Bicycle Planning and Infrastructure.** Enhanced investment in local and regional bicycle facilities, including planning and construction.
- 2. **Bikes-on-Transit Investments.** Investments in transit-related bicycle facilities, including bike racks on buses, bike lockers at transit stops, etc.

6. Ramp Metering

Brief Description: The control of vehicles input into a freeway system by the use of traffic lights at on-ramps. Its objective is to achieve maximum flow and prevent the onset of congestion. This strategy has to be interactive with the changing demand patterns throughout the day (and week). Also, it has to react to incidents or lane closures and if its presence at a location changes the demand pattern, the metering should track and change accordingly.

Overview of Strategies:

- 1. Eastbound-on at Empire Junction
- 2. Eastbound-on at East Idaho Springs
- 3. Eastbound-on at SH 103

Estimated Effectiveness Range (reduction in peak-period travel demand):

Studies in the nation suggest an improvement in travel time of up to 7%.

Detailed Description of Strategies:

- 1. Ramp metering at the eastbound on-ramp at Empire Junction could help mitigate the congestion caused by the merge. Public opinion could be a potential problem due to the increased delay at the on-ramp.
- 2. The eastbound on traffic at East Idaho Springs, if metered, could possibly prevent congestion on I-70. The presence of the frontage road as an alternate route would make it even more effective.
- 3. Metering at SH 103 would have a similar effect as at East Idaho Springs. The frontage road could serve as an alternate route here as well.

Conclusions:

Ramp metering is a viable solution only if there is some route choice for the traffic entering the highway. Adding a ramp meter at Empire Junction is not a reasonable alternative. If traffic entering eastbound I-70 from US 40 was limited to the amount of available capacity on I-70, the resulting queues would stretch for miles on US 40 and extreme increases in travel time for traffic coming from Berthoud Pass would result. The only alternative to waiting through the ramp meter would be to go west on I-70 and get onto I-70 at an unmetered location or take one of the frontage roads in this area. If traffic diverts to unmetered locations, then the I-70 traffic flow improvements would not be realized. The frontage roads in this portion of the Corridor are already heavily traveled during peak hours and pass through heavily populated areas. Encouraging traffic to travel on them is contrary to the goals of this study.

Ramp metering at the two Idaho Springs interchanges could be a viable alternative, if appropriate changes were made to provide an alternate route between Idaho Springs and the base of Floyd Hill. The necessary changes include five elements, as listed below, from the Minimal Action alternative:

- SH 103 interchange
- East Idaho Springs interchange
- Improve frontage road from East Idaho Springs to Hidden Valley
- Build new frontage road, with bike path, from Hidden Valley to the base of Floyd Hill/US 6
- Base of Floyd Hill/US 6 interchange

The primary purpose of the ramp metering would be to limit the traffic feeding on at the East Idaho Springs interchange. This traffic input, when combined with the eastbound flow already on I-70, is a prime contributor to the heavily congested traffic conditions often observed between Empire Junction and Idaho Springs.

The location at SH 103 would serve to limit traffic diverting from the East Idaho Springs interchange. The benefits of this alternative include:

- Improve mainline I-70 travel conditions
- Provide an alternate route to I-70 in this area
- Has very low existing population along the frontage road
- Resolve safety and capacity issues at the interchanges

7. Slow-Moving Vehicle Plan

Brief Description: Increase capacity on I-70 for peak-hour, peak-direction travel by limiting the left lane to those vehicles that could maintain a specified minimum speed throughout the steep grades that are present on this highway. The slower traffic will be restricted to the right lane to achieve the higher capacity. Additional facilities that would help improve slow-moving vehicle travel at all times, such as chain-up, rest area, WIM and AVI facilities, would also be proposed as part of this alternative.

Overview of Strategies:

- 1. Climbing lanes
- 2. Parking/chain up or down facilities for trucks

Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$4,000,000 \$6,000,000
 - Annual: \$75,000 \$200,000

Detailed Description of Strategies:

- Lane restrictions (slower vehicles in the right lane only) at the following locations could improve the traffic conditions on I-70: Dowd Canyon to West Vail, Bakerville to EJMT (westbound), EJMT to Herman Gulch (eastbound), Downieville to Empire Junction (eastbound), and Georgetown to Silver Plume (westbound). These lanes will also improve safety by decreasing accidents caused due to high-speed differentials between vehicles. Adequate signing will also be provided to ensure that the lane restrictions are conveyed to the roadway users. Adequate enforcement would be an essential element of this plan, without which the benefits could not be achieved.
- 2. Chain up or down and parking/rest areas for trucks will help in improving operations of these heavy vehicles by improving their performance.

8. Enhanced Incident Management

Brief Description: Mitigation of adverse effects of incidents on I-70 through real-time congestion and incident information for dispatchers, incident response vehicles, coordinated response to incidents with local agencies, dynamic routing of emergency vehicles based on current traffic conditions, computer aided

dispatch system and wireless communication equipment for emergency response, and automated incident detection.

9. Winter Park Ski Train

Brief Description: The ski train is an effective way of going to the Winter Park ski resort. It runs on tracks owned and operated by the Union Pacific Railroad and therefore, is subject to their requirements. Currently, one ski train a day goes to Winter Park on Fridays, Saturdays, and Sundays. Given the requirements of Union Pacific Railroad, at most one more trip could be added to each of these days.

Detailed Description of Strategies:

1. The added trip could be potentially helpful to many people, but its limitations in number of trips and locations does not make it a very effective alternative for I-70 recreational traffic.

10. Buses/Shuttles in Mixed Traffic

Brief Description: Provision of support for rolling stock purchases and implementation of minimum revenue guarantees for private transportation providers providing connections between Denver International Airport and Front Range locations and the I-70 Mountain Corridor.

Overview of Strategies:

1. Capital Investments and Subsidies for Private Transportation Services

Estimated Cost Range:

- Basic Implementation:
 - Start-up: \$50,000 \$75,000
 - Annual: \$500,000 \$2,000,000
- Aggressive Implementation:

•	Start-up:	\$100,000 - \$200,000
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• Annual: \$2,000,000 - \$6,000,000

Estimated Effectiveness Range (reduction in peak-period travel demand):

• Basic Implementation:

•	Summer:	.25 - 1%
		4 9.44

- Winter: 1 3%
- Aggressive Implementation:

•	Summer:	.5 - 2%
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• Winter: 2-4%

Detailed Description of Strategies:

1. Capital Investments and Subsidies for Private Transportation Services. Explore support for rolling stock purchases and minimum-revenue guarantees for private transportation providers serving long-range trips between DIA and



the Front Range and I-70 Mountain Corridor destinations. Private provider partners would participate in Colorado Mountain Plus programs.

11. Limited-Access Frontage Road

Brief Description: Limit travel on the frontage roads between Hidden Valley and Bakerville to usage by transit vehicles and Clear Creek County residents during peak travel hours. Electronic card-controlled access gates would control access. This would be an effort to increase transit usage in the Corridor by decreasing transit vehicle travel times.

Detailed Description of Strategies:

1. The limited access to the frontage road between Hidden Valley and Bakerville, it is hoped, would encourage the use of transit and thereby reduce traffic on I-70. This alternative would provide some encouragement to Corridor travelers to take transit, but the other mode choice variable that would be affected would be the travel time. Other important considerations, such as cost, frequency, and connectivity, would not be affected. It is unclear if this strategy would provide any net benefit.

COST SUMMARY	BASIC		AGGRESSIVE	
	Start-Up	Annual	Start-Up	Annual
Peak-spreading and Vehicle-occupancy	\$250,000 -	\$300,000 -	\$500,000 -	\$1,500,000 -
Increases	\$500,000	\$1,500,000	\$750,000	\$3,000,000
Enhanced Traveler Information	\$100,000 -	\$100,000 -	\$500,000 -	\$400,000 -
	\$250,000	\$400,000	\$5,000,000	\$2,500,000
Park-n-Rides	\$1,000,000 -	\$50,000 -	\$3,000,000 -	\$100,000 -
	\$2,500,000	\$150,000	\$10,000,000	\$500,000
Parking Operations Plan	\$50,000 -	\$75,000 -	\$50,000 -	\$300,000 -
	\$200,000	\$200,000	\$400,000	\$600,000
Bicycle Improvements	\$0	\$50,000 -	\$0	\$500,000 -
		\$500,000		\$1,000,000
Slow-moving Vehicle Plan	\$4,000,000 -	\$75,000 -		
-	\$6,000,000	\$200,000		
Buses in Mixed Traffic	\$50,000 -	\$500,000 -	\$100,000 -	\$2,000,000 -
	\$75,000	\$2,000,000	\$200,000	\$6,000,000

Summary of Transportation Management Strategies

	BASIC		AGGRESSIVE	
EFFECTIVENESS (reduction in peak period travel)	Summer	Winter	Summer	Winter
Peak-spreading and Vehicle-occupancy Increases	2 - 4%	4 - 8%	3 - 6%	6 - 10%
Enhanced Traveler Information	.25 - 1%	.5 - 1.5%	1 – 2%	2 - 3%
Park-n-Rides	.255%	1 - 3%	1 - 3%	3 - 6%
Parking Operations Plan	.5 - 1%	1 - 3%	.5 – 2%	4 - 15%
Bicycle Improvements	05%	025%	.5 - 1%	05%
Slow-moving Vehicle Plan	NA	NA	NA	NA
Buses in Mixed Traffic	.25 - 1%	1 - 3%	.5 – 2%	2 - 4%



Recommended Transportation Management Strategies

Alternatives that have the capability to help respond to the purpose and need of the PEIS in an efficient manner include the following:

- 1. Peak-spreading and vehicle-occupancy incentives
- 2. Enhanced traveler information
- 3. Park-n-rides
- 4. Parking operations and incentive plan
- 6. Ramp metering
- 8. Enhanced incident management

We recommend that the following alternatives be screened out, as they do not have the capability to help respond to the purpose and need of the PEIS, in an efficient manner in:

- 5. Bicycle improvements
- 7. Slow-moving vehicle plan
- 9. Winter Park Ski Train
- 10. Buses/shuttles in mixed traffic
- 11. Limited-access frontage road

Implementation Considerations

The distinction between *designing* Transportation Management strategies for the I-70 Mountain Corridor and *implementing* these strategies should not be overlooked. Unlike many "build" strategies, the development, implementation, and management of many Transportation Management strategies rely heavily on the fully integrated involvement of the private sector. Resort organizations, major employers, developers, building managers, business associations, retailers, and others have tremendous influence over the traveling habits of employees, visitors, and shoppers. Public sector organizations responsible for transportation and planning in an area can make travel options available and more convenient, but the demand for these facilities and services is largely determined by operational policies set by the private sector. The synergism of multiple organizations and individuals banding together can often accomplish more than any one government agency, employer, developer, or resident could do alone.

Transportation Management Associations. Currently, there is no organization within the I-70 "functional area" (see page 4) with responsibility or investment in coordination and funding of Transportation Management strategies. The feasibility of a Transportation Management Association (TMA) should be explored to engage both public- and private-sector stakeholders in program design, funding, and implementation.

Transportation Management Associations – An Overview

Communities throughout the United States have struggled with many of the issues discussed above. Responding to the need to foster long-term public-private partnerships designed to implement Transportation Management programs and projects, many communities across North America and Europe have formed organizations called Transportation Management Associations (TMAs). There are currently six TMAs in the state of Colorado and more than 150 across North America.

What is a TMA? TMAs generally exist as independent, non-profit organizations, funded by key public- and private-sector stakeholder groups (for example, government agencies, major employers, developers, business/resort associations, public and private transportation providers, etc.). Representatives from each key stakeholder group form the TMA's steering committee, with a professional staff of one to four people responsible for planning and implementing Transportation Management programs (either alone or in partnership with other organizations). The independent nature of the TMA allows stakeholders to formulate an action plan that reconciles various individual interests and provides various tangible benefits to each participating organization.

Colorado Mountain Corridor Transportation Management Association (CMC-TMA)

A TMA serving the I-70 Mountain Corridor (referred to in this section, for discussion purposes, as the "CMC-TMA") could cover the I-70 Corridor between west Denver and Vail/Glenwood Springs, along with several of the communities with close ties to I-70 from an access perspective (for example, Breckenridge, Winter Park, etc.). CMC-TMA members would likely include all major publicand private stakeholder organizations that affect, and are affected by, transportation dynamics on I-70. For example, participants could include:

- Chambers of commerce and resort associations
- Ski resorts
- Lodging companies and associations
- City and counties
- Colorado Department of Transportation (CDOT)
- Public transportation providers (for example, Summit Stage, Eagle Transit, Regional Transportation District, etc.)
- Private transportation providers
- National Forest and State Park representatives
- Travel agency/travel planning representatives
- Airline and car rental representatives



- Gaming representatives
- Others

Potential Roles for a CMC-TMA

The following items represent potential roles and responsibilities for a Colorado Mountain Corridor TMA:

- **Transportation Service Coordination.** Providing a forum for coordination and collaboration among key transportation providers in the Corridor (for example, CDOT, Summit Stage, Eagle County Transit, ski resort transit systems, lodging shuttles, private transportation providers, etc.). Coordination would focus on achieving economies of scale and simplifying travel choices for visitors.
- **Coordinated Marketing and Education.** Integration of marketing for I-70 destinations with marketing of travel choices to and within the Corridor. Production of coordinated schedule/route maps that incorporate multiple transit providers. Development of advanced traveler information systems and integration of these systems with visitor information distribution channels.
- Advocacy. Collective advocacy for continued transportation and economic development investments throughout the Corridor, including advocacy at the national level for federal and foundation funding. Public-private partnerships with diverse stakeholder representation can be very effective in this regard.
- Employee Mobility Programs. Working closely with major employers in the Corridor to develop employee mobility programs to improve access to labor markets in response to the jobs-housing imbalance issues facing many resort communities along I-70. Programs could include employee shuttles, vanpools, and carpools coordinated among multiple employers in an area, and the development of enhanced transportation information for employees (including multi-lingual transit maps/schedules that cover all transit providers in an area).

TMA Development – Next Steps

Forming a TMA is similar to starting a new business. Before getting off the ground, extensive research should confirm the viability of the business concept. A TMA Feasibility/Formation Study (often sponsored by public-sector seed funding) typically includes evaluation of:

- the overall level of need, and logical boundaries, for a TMA,
- the types of services a TMA could provide,
- the level of support for a TMA from key stakeholder groups, and
- the availability of adequate financial commitments to support a TMA (both initially and over time).

Appendix A: North American Case Study Research

The following section details case studies from 11 North American case studies researched for this project to establish a context for the development and evaluation of Transportation Management strategies for the I-70 Mountain Corridor.

Case Study Locations

- 1. The Lake Tahoe Region, California/Nevada
 - Various corridors including Nevada State Route 28, California's I-80, California Highway 50
- 2. Whistler-Blackcomb, British Columbia
 - Highway 99
- 3. Cape Cod National Seashore, Massachusetts
 - Route 6
- 4. Florida Keys
 - US 1 from Miami to Key West
- 5. National Parks
 - Great Smoky National Park Cades Cove Loop
 - Acadia National Park
 - Grand Canyon National Park
 - Zion National Park
 - Yosemite National Park
- 6. Washington State
 - I-405 corridor
- 7. I-93: Salem to Manchester, New Hampshire



Case Studies

1. Lake Tahoe Area

Multiple entry points to Lake Tahoe's popular skiing, casinos, and outdoor recreation activities allow an influx of visitors to the two main business centers within the basin. Travel on seven of the main access routes increased 20 percent from 1981 to 1995 and an additional 8.85 percent from 1995 to 1999. Various regional and local organizations within the Tahoe Basin have been involved with developing strategic Transportation Management strategies targeted to the visitor. Additionally, multiple corridor-oriented strategies have been developed.

General Regional Strategies

- 1. **Ski Resort Bus Service:** Heavenly Resort on South Lake Tahoe provides a free shuttle bus for skiers. The bus system picks skiers up at various lodging establishments and shuttles them to Heavenly Ski Resort. These buses are operated by the public bus system but exclusively for Heavenly Resort. North Lake Tahoe ski resorts offer similar shuttle services. The ski resort shuttles are advertised on various websites, both resort-oriented and general Tahoe visitor information oriented websites.
- 2. **Casino Transit:** Tahoe Casino Express operates luxury bus transit service from the Reno Airport to Lake Tahoe casinos. Last winter, the fee per rider one way was \$19.00. Casinos initially subsidized the bus service, but it is currently self-sustaining and operated by a private company. The Casino Express provides ample room for ski and snowboard gear. A similar casino-oriented luxury bus service is currently being discussed for the Sacramento to Tahoe corridor.
- 3. **Internet Information:** As mentioned, ski resorts advertise their free shuttles on various Tahoe travel and informational websites. In addition, the Tahoe Transportation District's website provides information on a car-free Tahoe vacation and links to both private and public transportation options within and to the Tahoe basin.
- 4. **South Lake Shuttle**: The South Lake Tahoe Transportation Management Association (TMA) found that 90 percent of bus ridership was resident and only 10 percent tourist/visitor. Focusing on a general philosophy that any visitor-oriented transit options should be fun, easy, and innovative, the TMA looked to Disneyland for models of visitor mobility. They initiated a seasonal trolley system within the city and marketed it toward visitors. After a year of operation, a ridership survey revealed that 90 percent of trolley riders were tourists/visitors and 10 percent were residents. Furthermore, overall ridership has increased each year until 2001.
- 5. North Shore Trolley: Similar to the South Lake Shuttle, the North Shore Trolley is a summer-only form of public transportation marketed toward visitors. A recent ridership survey found that 60 percent of users were visitors

to the area and 50 percent of them had access to cars. The Trolley, which was initially operated by the Truckee/North Tahoe TMA (TNTTMA), is currently managed by the county and paid for by private businesses.

6. Ski Resort Coalition: Recognizing the direct interest the ski resort community has in ensuring efficient and accessible transportation options in the North Lake Tahoe area, the TNT/TMA convened a ski resort coalition. This coalition has been involved with improving and enhancing public and private transit for employees and visitors. Together, they advocated and paid for expanded service along SR 89 during the winter, which resulted in increased ridership. In addition, the ski resort coalition takes on some responsibility for funding innovative and enhanced transportation options. Although the ski resorts in North Lake Tahoe are involved in the regional employer rideshare program, each ski resort offers employees unique incentives for taking public transportation. For example, some provide discounted meal tickets while others provide recreation-related incentives.

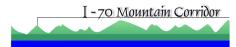
Corridor Specific Strategies

- 1. **State Route 80:** SR 80 is the main corridor connecting the Sacramento and San Francisco Bay Area with the Lake Tahoe region.
 - **Proposed Rail:** Numerous I-80 corridor studies have been conducted including a study to determine the feasibility of developing rail service between Sacramento and Reno via Lake Tahoe. The California Department of Transportation (CalTrans) found that 80 percent of the 2.1 million travelers to Lake Tahoe are skiers and, therefore, tailored the rail study to address skier-oriented travel. Annual ridership on the I-80 corridor rail service was estimated to be approximately 230,000. Due to political and economic reasons, the plan was not approved.
 - Choke-Point Management: Currently, CalTrans is working on improving inter-regional travel (such as that to Lake Tahoe) by focusing on improving mobility through choke points in urban areas and enhancing bus service. CalTrans is starting to focus more on TDM strategies and their consequential modal shift, but much of the analysis is currently being completed and unavailable.
- 2. **Highway 89:** Highway 89 connects I-80 with Lake Tahoe. Recreationinspired congestion on SR 89 is a concern, yet due to the high cost of environmental mitigation, highway expansion is not possible.
 - **Bicycle Trail:** A new bike trail takes cyclists off Hwy 89, designed partly with the intent of giving visitors a viable alternative to automobile once at Lake Tahoe. This trail will connect cyclists with a newly constructed trail that circumnavigates the Lake.
- 3. **State Route 28:** SR 28 is a popular winding scenic two-lane highway in East Lake Tahoe linking major destination areas in the Tahoe Region while

providing access to popular beaches, trails, and vistas. Recently, parking along SR 28 demand exceeded supply causing visitors to park on the fragile, "prone to erosion" shoulders. The combined effect of erosion and access limitations lead to the development of a Recreational Traffic Management study with the goal of managing recreational traffic along State Route 28 to US Highway 50. The Tahoe Regional Planning Agency (TRPA), the Truckee-North Tahoe Transportation Management Association (TNT/TMA), and the Nevada Department of Transportation (NDOT) partnered to design a plan that would:

- Minimize the environmental impact of recreational travel along the corridor
- Manage recreational traffic to reduce visitor impact on natural resources, encourage alternative modes of transportation
- Reduce the impact of recreational traffic and parking on the capacity and level of service of SR28.

Using traffic analysis data, resident and visitor surveys, and field observances, the study identified key facts regarding recreational travel on SR 28. These facts drove the creation of four main alternatives and the selection of the preferred alternative. The table below outlines the recommended alternative, costs, and effectiveness of the alternative.





SR 28 Recreational Traffic Management Study Recommendations, Costs, and Effectiveness

Parking	Eliminate all shoulder parking Construct new lots where possible near destinations Construct new lots to be served by a peak season shuttle
Shoulder Parking Control	Use physical barriers such as guardrails and sign posts
Shuttle	Operate during peak periods Serve intercept lots and new lots
Enforcement Program	Two full-time seasonal parking control officers
Informational/Educational Program	Inform drivers accessing the area before they arrive Regional advertisements Brochure AM radio, highway signage
Total Construction Costs	\$1,705,100
Total Annual Operating Costs	\$204,900
Parking Revenues	\$25,550
Parking Violation Revenues	\$100,000
Daily VMT Reduction	Approximately 1,434 VMT, or 9.6 percent
NOx Reduction	2,681 grams per day or 0.01 percent of the estimated average summer day emissions

The plan concluded with detailed information regarding establishing an East Shore Recreation Traffic Oversight Committee. This committee would include members from key local, state, and federal organizations and would be responsible for developing an evaluation and monitoring plan. In addition, the plan recommends that a managing entity be assigned daily operational responsibilities of the plan. A local transit district was suggested as the managing entity.

Sources:

- 1. Nevada State Route 28 Recreational Traffic Management Study. 1995. http://tahoe.ceres.ca.gov/lsc/tbl_con.html
- 2. South Lake Tahoe TMA Executive Director, Dick Powers. Phone conversation November 1, 2002.
- 3. Virtual Tahoe transportation information. www.virtualtahoe.com
- 4. CalTrans. Mark Dinger and Karen Peneschi. Conversations October 27 and October 30.
- 5. Tahoe Transportation District Car-Free website. http://www.virtualtahoe.com/playground/GettingAround/TTD/TTD.html

2. Whistler-Blackcomb British Columbia, Canada

The two-lane Highway 99, otherwise known as the Sea to Sky Highway, is a popular tourist route. One of the most popular spots along the route is the Whistler-Blackcomb ski area; the largest ski area in North America with more than 7,000 acres of skiable terrain. In addition to its popularity as a ski resort, the area is well known for its mountain biking, hiking, and other non-winter activities. Congestion on Highway 99 and in the Village of Whistler during peak winter afternoon periods is excessive, and year-round congestion on Highway 99 is growing. Thus, Whistler is looking at various tourist- and employer-oriented strategies to improve travel times. In addition, Whistler, British Columbia, is in the bid process for the 2010 Winter Olympics.

Strategies

- 1. **Shuttle:** The Village of Whistler sponsors a free shuttle within the town of Whistler with service to the Blackcomb Mountain Base Lodge.
- 2. **Public Transportation:** The local transit provider, WAVE, provides public transportation around the greater Whistler area. WAVE serves more than 2 million riders on 23 buses and operates from 5:00 AM to 3:30 AM. Buses are equipped with ski racks in the winter and bike racks in the summer. Passes are available in various increments (1 or 30 days and/or 5, 10, or 20 rides). Free transit rides are provided on important days such as World Earth Day, Clean Air Day, International Car Free Day, and New Year's Eve. Wave provides service from Vancouver, British Columbia, and Vancouver Airport (\$160 and \$180 respectively) to Whistler.
- 3. **Preferential Parking:** Whistler Village provides priority parking to carpools and vanpools.
- 4. **Comprehensive Transportation Strategy:** The Transportation Advisory Group (TAG), a public-private partnership tasked with addressing transportation issues in Whistler, created a Comprehensive Transportation Strategy that, in addition to outlining new land use policies, transit enhancements, and roadway improvements, includes innovative TDM and parking management and strategies.

TDM Strategies

- Skier Program: Manage travel demands on peak skier days with a Peak Day Program that encourages alternative modes and discourages use of the private automobile by
 - Providing free transit service
 - Implementing pay parking strategies
- Hours of Operation: Explore modification of mountain operating hours on peak days to spread out traffic peaks along with more flexible ticketing options.



- **Commute Trip Reduction:** Establish and promote an Employer Trip Reduction Program. Research the possibility of combining a transit pass and lift pass for employees who use the bus.
- Visitor Rideshare Program: Organize a rideshare program for Whistler day visitors. Provide a van/shuttle service from Vancouver to Squamish, Pemberton, and Whistler.

Parking Management Strategies

- Limit skier parking to existing levels; no net gain in parking capacity except efficient parking operations.
- Expand pay parking.

Effectiveness

Effectiveness, either planned or resulting from the defined TDM strategies, was unavailable. Important to note is that the TAG recommends that TDM programs and enhancements to transit and non-motorized modes should occur before any roadway enhancements or construction occurs. They have set a flexible goal of a 15 percent reduction of automobiles in peak hours (reduction based on projected growth in traffic volumes as if no TDM measures were in place).

Sources:

Information gathered primarily from the following documents:

- Comprehensive Transportation Strategy. Summary Report. The Transportation Advisory Group. <u>http://www.whistler.ca/reading/documents/Transport%20Strategy.pdf</u>
- The Vancouver-Whistler 2010 Olympic bid: Transportation Solutions for the Winter 2010 Olympics . Buehrmann, Sebastian. <u>http://www.sfu.ca/~geo449/transportation/Technologies%20and%20Solutions</u>.<u>pdf</u>

3. Cape Cod National Seashore

The Cape Cod National Seashore and the unique 15 towns that line Route 6 draw thousands of visitors every year to explore and relax. Unfortunately, seasonal traffic congestion has decreased mobility along Route 6 for visitors and year-round residents. The Cape is known as a car-dependent area because of various factors including the lack of transportation service coordination, coupled with an overall lack of knowledge regarding public transportation options among residents and visitors. In an effort to recognize and respond to the growing congestion problems, the Cape Cod Transit Task Force is proposing a 25-year transportation. The Task Force is working toward a solid vision statement:

"I CAN get there from here WHEN I want to go."



Strategies

Key elements of the plan aimed at both recreational users and year-round residents of the Cape Cod area include:

- **Coordination:** Improve the coordination between the large numbers of transportation providers on the Cape.
- Education: Increase public awareness of transportation options available on and to the Cape including accessibility by bus, ferry, bike, rail, and road.
- **Efficiency:** Increase efficiency of transportation system and decrease duplication where it exists.
- Exclusiveness: Identify and address service gaps.

Increasing the frequency of the Cape Cod Regional Transportation Authority's bus service, including expanding to year-round Sunday service and adding services to both underserved areas and whale watch departure points, and building a new bus-only lane on Route 6 from Sandwich to Sagamore Bridge are two specific elements of the Task Force's proposal. The development of hub transportation facilities that serve as multimodal centers is also a key piece of the proposal.

Effectiveness:

Because the Cape Cod Task Force is in the planning stages and the alternatives are currently being analyzed, effectiveness (including proposed effectiveness) measures for the TDM strategies are unavailable.

Cost and Funding:

Estimated costs for entire program:

- Capital improvements: \$41 million
- Operating improvements: \$19.5 million

In addition to accessing traditional local, state, and federal funding sources, the Task Force includes the provision of additional revenues through the following ways:

- New tax revenues from Barnstable County.
- Adjustment of federal formulas to base Cape's funding on seasonal population.
- Use of dedicated revenue from new, seasonal, or year-round user fees on rooms, sales and/or gasoline.



Sources:

Information gathered primarily from Internet research including access to the following documents:

- 1. Cape Cod Five-Year Transportation Plan 2002-2007
- 2. Cape Cod Regional Transportation Authority; http://www.capecodtransit.org/

4. US 1 from Miami to Key West

Popular Key West and the Florida Keys are accessible by road via US 1 from Miami. With the exception of congestion along an 18-mile stretch of US 1, the four-lane signalized highway seems to handle capacity well. Discussions with individuals from Broward County and the Florida Department of Transportation resulted in the discovery that no TDM strategies have been planned or considered for US 1. Two reasons were given for this: (1) a perception that there is no need for TDM on the corridor and (2) TDM would require coordination between the numerous jurisdictions on the Florida Keys. Building consensus between these jurisdictions has proved difficult.

Main Sources:

Information gathered primarily from Internet research and phone conversations including:

- 1. Phone conversations with Ken Jeffries at FLDOT and Ernesto Polo at Broward County
- 2. South Florida Regional Planning Council. http://www.sfrpc.com/
- 3. Strategic Regional Policy Plan for South Florida. http://www.sfrpc.com/ftp/pub/srpp/srpp0895.pdf

5. National Parks

Each of the following case studies describes traffic issues within a National Park governed by the National Park Service. Given this governance structure, each case study shares the National Park Service's transportation mission to "preserve and protect resources while providing safe and enjoyable access within the National Parks by using sustainable, appropriate and integrated transportation solutions."¹ Each park is responsible for developing a General Management Plan, with the exception of congressionally mandated projects and emergency rehabilitation. These plans are to be linked with local land use and transportation planning efforts to the highest extent possible. To achieve the transportation mission, the National Park System is currently gathering and analyzing alternative transportation system (ATS) effectiveness data and traveler/visitor data. The data will be analyzed in fiscal year 2003 to determine effectiveness of the various ATS strategies implemented.

a. Great Smoky National Park- Cades Cove Loop

Receiving more than 2.5 million visitors a year, the Cades Cove Loop, located in the Great Smoky Mountains National Park, is one of the park's most popular tourist destinations. Visitors enjoy rare glimpses of wildlife, multiple national historical sites, and spectacular natural beauty. The annual number of vehicles on the 11-mile one-way loop has quadrupled since 1970. Heavy visitor use is damaging the natural and cultural resources of the park while impeding on the quality of the visitor's experience. Most travel on the Cades Cove Loop is auto oriented, and on days when the traffic is light, the 11-mile loop is an hour's drive. Yet, during busy seasons (such as summer and the month of October), this increases to an average drive of 3 hours.

Strategies

In partnership with the regional Metropolitan Planning Organization (MPO), the Great Smoky National Park is currently developing the Cades Cove Opportunities Plan (CCOP). This plan will outline key transit and transportation demand management (TDM) strategies, all consistent with National Park Service goals, policies, and procedures, aimed at increasing accessibility of Cades Cove and mobility options for visitors. Visitor experience and the preservation of the Cove are key to the CCOP. The CCOP lists various core technology alternatives including:

- Light rail
- Cog railway
- Open-air tram
- Conventional bus

¹ National Park Service Transportation Alternatives Department. http://www.nps.gov/transportation/alt/fotstatus.htm



- Electric shuttle bus
- Articulated bus
- Over the road coach

Each technology alternative was measured against the following criteria:

- 1. Operational (Will the strategy fit easily into existing infrastructure? Do proven applications exist? Will efficient loading and unloading of passengers occur?)
- 2. Impact on visitor's experience
- 3. Ability to meet visitor demand
- 4. Resource issues
- 5. Infrastructure requirements

Demand management strategies are also included in the CCOP as complementary strategies to the technology strategies listed above.

Traffic Management Strategies Considered in the CCOP

Access restrictions: Limit the number of cars permitted to enter the cove at any give time with the intent of ensuring the volume of cars in the Cove is less than capacity allowed.

ITS: Consider ATIS to inform visitors about wait time, parking availability, and/or roadway and weather conditions

Bike and Pedestrian Modes: Include bike racks on the chosen transit vehicles, improve access to sites and the Loop, and encourage the use of these modes through expanding onsite rental facilities and ranger bike tours and a public information campaign. Currently, the road is closed to motor vehicles Saturdays and Wednesdays from early May to late September until 10:00 AM to enable bicyclists and pedestrians to travel the loop safely.

Effectiveness

Because the CCOP is in the planning stages and the alternatives are currently being analyzed, effectiveness (including proposed effectiveness) measures for the TDM strategies are unavailable. The TDM strategies are designed to complement and enhance the preferred technology alternative, which is yet to be determined.

Main Sources:

Information gathered primarily from Internet research including access to the following documents:

1. Cades Cove Technology Assessment (August 2001); Regional Transportation Alternative Committee. <u>www.knoxtrans.com/rtap/index.htm</u>



- 2. Cades Cove Opportunities Plan website. <u>http://www.cadescoveopp.com/</u>
- 3. Park Announces Experimental Cades Cove Traffic Measures. <u>www.nps.gov/grsm/gsmsite/newscovetraffic.html</u>

b. Acadia National Park

Visitors to Acadia National Park located in Maine, just 6 hours north of Boston, enjoy rocky Atlantic shoreline and beaches, mountainous terrain and numerous wilderness lakes and ponds. Unfortunately, auto use in the park has begun to negatively impact both the park's natural resources and the visitor's experience. The park has made multiple efforts to reduce visitor auto dependency by initiating a few innovative and effective programs.

Strategies

1. Shuttle Service: In an effort to provide mobility to visitors and decrease the usage of automobiles within the park, in 1999 Acadia initiated a free shuttle service, the Island Explorer. The Island Explorer provides service between campsites, beaches, the main town, and hiking trailheads. Annual ridership surveys report increasing ridership and overall customer satisfaction. Currently, the shuttle is a seasonal service provided by a private concessionaire and is used by commuters, residents, and visitors.

Island Explorer Ridership		
Year Riders 1999 142,000		
2000 193,057		
2001 239,971		

- 2. **Online Trip Planner:** Visitors planning a trip to Acadia National can access various alternative transportation options and information online. The online trip planner provides future visitors information regarding access to and within Acadia National Park, including the "8 Car-Free Ways to Get to Acadia" brochure, and a link to the free Island Explorer Shuttle service.
- 3. **Car-Free Day:** Every fourth Sunday in April Acadia sponsors a "car-free day."

Effectiveness

Annual surveying of shuttle riders provides information on the shuttle experience and ridership. These surveys report overall rider satisfaction and increasing usage, yet they do not include information regarding modal shift resulting from the shuttle service. As mentioned earlier, the National Park Service is currently gathering and analyzing ATS effectiveness data and traveler/visitor data.

Main Sources:

Information gathered primarily from Internet research including access to the following documents:

- 1. Acadia National Park Trip Planner. http://www.nps.gov/acad/planner.htm
- 2. Volpe Center- National Park Projects. http://www.volpe.dot.gov/index.html
- 3. Information provided by contact at Volpe Center regarding overall National Park System TDM and Transit effectiveness study efforts.

c. Grand Canyon National Park

Visitors to the Grand Canyon often experience a long wait at each of the park entrance stations. Each year, 5 million visitors make their way to Grand Canyon, resulting in overcrowding and traffic congestion particularly during spring, summer, and fall. The Grand Canyon's General Management Plan outlines the following strategies to combat congestion.

Strategies

- 1. **Proposed Rail:** The 1995 General Management Plan initially called for the development of a rail system within the park to meet visitor demand. Upon further research into visitor projections, the rail alternative was replaced by enhanced transit options.
- 2. **Shuttle System:** A free shuttle at the Canyon's South Rim transports visitors to various popular viewpoints along the South Rim. The Grand Canyon plans on enhancing the shuttle, which currently runs at 15-minute frequencies from 7:30 AM to sunset, and less frequently 1 hour before and after sunrise/sunset. The shuttle will eventually operate year-round, feature an evening taxi service, and be able to respond more flexibly to visitor needs.
- 3. **Parking Management:** Most day visitors to the Grand Canyon will soon need to leave their cars outside the park and ride the enhanced shuttle system within the park. In addition, the General Management Plan includes plans to better integrate internal park shuttle service and parking.
- 4. **Private Shuttles:** Greyhound provides private bus service from Flagstaff and Williams to the canyon.
- 5. **Online Travel Information:** Visitors anticipating a trip to the Grand Canyon can use the online trip planner. This trip planner clearly warns day-use visitors of congestion and parking problems within the park and encourages visitors to plan on long delays, use the shuttle, or plan their trip during less congested times.

Effectiveness

As mentioned earlier, the National Park Service is currently gathering and analyzing ATS effectiveness data and traveler/visitor data. Initial reports point to improved air quality within the Canyon since the inception of the policy.

Main Sources:

Information gathered primarily from Internet research including access to the following documents:

- 1. Grand Canyon National Park Trip Planner.
- 2. Volpe Center- National Park Projects. http://www.volpe.dot.gov/index.html
- 3. Grand Canyon National Park General Management Plan. www.nps.gov/grca/gmp/index.htm
- 4. Information provided by contact at Volpe Center regarding overall National Park System TDM and Transit effectiveness study efforts.

d. Zion National Park

Strategy

In spring 2000, Zion National Park, located in Utah, initiated an aggressive alternative transportation plan within the scenic and popular 6.5-mile Zion Canyon. From April through October, the Zion Canyon Scenic Drive is accessible only by shuttle bus or tram. Visitors intent on viewing the canyon must park their vehicles at the visitor center or outside the park in the nearby town of Springdale. The shuttle system connects with the nearby town of Springdale in a manner that discourages congestion in the town. Bike racks are available on the shuttle, which is free and operates at a 6-minute frequency.

Effectiveness

As mentioned earlier, the National Park Service is currently gathering and analyzing ATS effectiveness data and traveler/visitor data. Initial reports point to improved air quality within the park since the inception of the policy.

Main Sources:

Information gathered primarily from Internet research including access to the following documents:

- 1. Zion National Park Trip Planner. http://www.nps.gov/zion/trans.htm
- 2. Volpe Center- National Park Projects. http://www.volpe.dot.gov/index.html
- 3. Information provided by contact at Volpe Center regarding overall National Park System TDM and Transit effectiveness study efforts.

e. Yosemite National Park

Strategy

Similar to Zion National Park, Yosemite National Park has instituted aggressive alternative transportation policies. Parking for day-use and overnight visitors is available but limited. Once the parking lots are full, visitors must park outside the park and board free shuttles. A fee-for-service hiker bus is also available providing service to multiple trailheads throughout the park.



Effectiveness

The National Park Service is currently working to establish a traffic information system to improve its ability to understand visitor travel patterns and modal shift opportunities. Nevertheless, areas that institute policies such as the Yosemite and Zion policies often experience improved air quality immediately.

Main Sources:

Information gathered primarily from Internet research including access to the following documents:

- 1. The Yosemite Valley Plan SEIS, Volume II, Appendix G. <u>www.nps.gov/yose/planning/yvp/seis/vo_II/appendix_g.html</u>
- 2. Yosemite National Park trip planner. http://www.nps.gov/yose/trip/

6. Washington State I-405 Corridor

Located in Washington State, Interstate 405 is a 30.3-mile bypass to the east of Seattle known throughout the region for its congestion. Due to population and job growth in the cities of Bellevue, Renton, Redmond, and Kirkland, drivers "suffer 12 hours in gridlock a day in the Renton area."² Traffic and congestion primarily result from commute, freight movement, and travel to and from Seattle for special events. The Washington State Department of Transportation (WSDOT) gathered the jurisdictions and decision makers affected by the I-405 congestion to create a corridor improvement plan. Transportation demand management advocates in the area worked diligently to educate the various jurisdictions on the merits of TDM. After much research, analysis, and partnership building, the I-405 Final EIS included TDM as a sole alternative and as an integral part of each of the other three alternatives.

The Final EIS presents the preferred alternative, which includes the following solutions:

- Implement an enhanced transportation demand management (TDM) program.
- Expand capacity of the existing bus transit system.
- Implement new rapid bus transit.
- Implement new HCT within the corridor.
- Expand the capacity of the existing corridor.
- Expand capacity and improve the continuity of the adjacent arterial network.

² http://www.wsdot.wa.gov/projects/I-405/



TDM Strategies

- 1. **Vanpooling:** Maximize vanpooling in the corridor by increasing the vanpool program 100 percent and initiating the use of new "value-added" incentives (for example, frequent flyer miles for vanpoolers).
- 2. **Public Information, Education and Promotions Program:** Establish an ongoing public education and awareness program specific to the corridor (focus on issues and transportation alternatives). Provide personalized trip planning assistance.
- 3. **Employer-Based Programs:** Increase work choices such as telecommuting. Provide incentives to employers to offer work choices (for example, tax credits). Develop parking cash-out program incentives.
- 4. Land Use TDM: Support compact, mixed-use, non-motorized, and transitfriendly (re) development, such as transit oriented-development (TOD), in target areas (urban centers, suburban clusters, key arterials, transit station areas, transit centers, park-and-ride lots). Develop new parking management programs.
- 5. **Other Miscellaneous TDM Programs:** Including innovative transit and vanpool fare media, incentives, demonstrations, matching funds, etc. Non-commute trips TDM programs (research and demonstrations).
- 6. **Expanded TDM Package:** Include consideration of the range of regional pricing strategies including:
 - a. Region-wide congestion pricing (RCP);
 - b. Fuel taxes (revenue = RCP);
 - c. Fuel taxes (revenue = 50% RCP);
 - d. Mileage charge (revenue = RCP);
 - e. Parking charges;
 - f. High occupancy toll lanes

The expanded TDM package is considered an add-on piece to the other TDM strategies listed and requires further analysis and public and political support.



Effectiveness and Cost

The table below reflects the estimated reduction in travel demand at various times of the day. The second table demonstrates the estimated cost for each TDM element.

1-405 TDM Flogram Enectiveness			
TDM Element	Estimated Reduction in Daily Travel Demand ³	Estimated Reduction in AM Peak Period Travel Demand ⁴	Estimated Reduction in PM Peak Period Travel Demand
Vanpooling	.9%	2.7%	1.6%
Public Information	.2575%	1.0-2.0%	.7%
Employer-Based	.5-1.0%	2.0-3.5%	1.5-2.5%
Land Use as TDM	1.0-2.5%	3.5-5.0%	2.0-3.5%
Miscellaneous Programs	.5-1.0%	1.25-2.5%	.75-1.25%
Total Estimated Travel Demand	3-6%	10-15%	7-10%
Pricing	15%	10-15%	7-10%
Total Estimated Travel Demand Reduction	18-21% (Note: May include some double-counting of benefits)	Not Estimated	Not Estimated

I-405 TDM Program	n Effectiveness
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Table 3.12-12 from the I-405 Corridor Program Final EIS

TDM Package Elements	Percentage of Funding	20 Year Funding (2000 \$\$\$)
Core Program*	4%	\$19,650,000
Vanpooling	27%	\$121,680,000
Public Information and Education	8%	\$33,750,000
Employer-Based Strategies	30%	\$135,800,000
Land Use	21%	\$95,500,000
Other TDM Programs	10%	\$45,620,000
TOTAL	100%	\$452,000,000

Nevertheless, despite the inclusion of a TDM package in each of the four alternatives and the Preferred Alternative, the Final EIS clearly states TDM quantification as a concern:

"The I-405 Corridor Program studied inclusion of a TDM program within the I-405 corridor. The empirical estimates of the TDM program's effectiveness were included in the documentation of impacts on travel demand within the study area. These effects could not be fully integrated into all of the transportation results due to limitations in the travel forecasting procedures. The Puget Sound Regional Council (the area's MPO) is conducting additional research to include more TDM effects into future versions of the model. Research to date suggests that the expanded program contained in the Preferred Alternative represents one of the most extensive corridor-based

³ Results measured in terms of percent reduction in vehicle miles traveled (VMT)

⁴ Pricing is included in Alternative 1 only. Regional congestion pricing effects have been studies as part of the PSRC's 2001 Update Metropolitan Transportation Plan (PSRC, 2000)

demand management and trip reduction programs anywhere in the United States."⁵

A series of Phase I priority improvements for the \$1.77 billion in state transportation funds to be allocated for I-405 if voters approve Referendum 51 have been identified. The Phase I plan is based on a "worse first" approach that includes a rebuilt and reconfigured Interstate 405/SR-167 connection and adding new lanes through the Renton area, fixing the urban congestion hot spots along the corridor.

Main Sources:

Information gathered from Internet research, conversations with I-405 staff including access to the following documents:

- 1. I-405 Corridor Program Final EIS. <u>http://www.wsdot.wa.gov/projects/I-405/feis/</u>
- 2. Phone conversation with John Shadoff of Washington Department of Transportation (TDM coordinator for the I-405 FEIS).
- 3. I-405 Project website. http://www.wsdot.wa.gov/projects/I-405/default.htm

7. I-93 Salem to Manchester, New Hampshire

In an effort to improve transportation efficiency and reduce safety problems along a 19.8-mile section of Interstate 93, the New Hampshire Department of Transportation (NHDOT) recently completed a draft environmental impact statement (DEIS). The DEIS presented six alternatives, which included separate TSM, TDM, and alternative modes of transportation alternatives.

Transpirations System Management Alternative: The TSM alternative included three major strategies designed as short-term, moderate cost solutions to I-93 congestion.

1. ITS: Including variable message boards, highway advisory radio, website information, and emergency reference markers.	Incorporated into overall improvements of corridor. Planning efforts to ensure I-93 ITS complements current regional and statewide efforts.
2. Shoulder Lane Usage: Use of shoulder during peak periods.	Requires widening a 3.9-mile corridor to provide minimum 12-ft. shoulder. Requires widening four bridges. Due to high construction costs, this strategy was not pursued.

⁵ Summary pp.14.

3. Ramp Metering

Due to the limited number of alternative routes and the limited impact of ramp metering, this alternative was not pursued.

Transportation Demand Management Alternative: The TDM alternative included three major strategies to combat I-93 congestion.

1. ITS: Including variable message signs, highway advisory radio, website information, and emergency reference markers.	Incorporated into overall improvements of corridor. Planning efforts to ensure I-93 ITS complements current regional and statewide efforts.
2. Employer Based Measures: Recognize the greatest success of TDM is through employers .	Most work-related travel is to workplaces in Massachusetts; therefore, these measures need to be implemented largely in Massachusetts by employers, government jurisdictions, and/or TMAs.
3. Congestion Pricing	Because peak-period congestion lasts 3 hours and because of the need for public support, this alternative was not pursued.

Alternative Modes of Transportation Alternative: The provision of alternative transportation modes was also considered.

1. Park and Rides: Build new park and rides to accommodate growth in transit usage.	Three new park-n-ride lots are included in the locally preferred alternative.
2. Bus Expansion: Expand current bus service. Connect service directly with new park and rides.	Included in the preferred alternative, particularly as a means to provide commuters with options during construction.
3. Bus Enhancement: Provide new access between New Hampshire employment centers on I-93 and those in Northern Massachusetts.	Included in the preferred alternative, particularly as a means to provide commuters with options during construction.
4. Congestion Pricing	Because peak-period congestion lasts 3 hours and because of the need for public support, this alternative was not pursued.



5. HOV Lanes: Shift lanes to HOV.

A New Hampshire only HOV lane does not produce sufficient ridership on buses or in carpools to warrant further testing.

Appendix B TranSystems I-70 Mountain Corridor Transit Alternatives July 2000 This page intentionally left blank.

I-70 Mountain Corridor Transit Alternatives

Prepared for:

Colorado Department of Transportation







Prepared by:



July 2000

I-70 MOUNTAIN CORRIDOR PROGRAMMATIC EIS: Identification of Transit Alternatives

DRAFT FINAL REPORT

Prepared For: J. F. Sato & Associates

Prepared By:



July 26, 2000

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IDENTIFICATION OF OPTIONS

Attributes of existing technologies were culled from various sources within the Transportation Research Board (TRB) of the National Academy of Sciences, Jane's World Railways, Jane's Urban Transport Systems, the American Public Transportation Association (APTA), the Association of American Railroads (AAR), the Federal Transit Administration (FTA), and the Federal Railroad Administration (FRA) of the United States Department of Transportation. Attributes of advanced guideway systems were provided by the technology proponents and in most cases have not been tested or verified under real-world operating conditions.

Technologies were divided into two families of transit with a number of groups within each family as well as various options within each group. These families and groups are:

• Rubber Tire Transit (RTT) Family

- 1. Buses in Mixed Traffic
- 2. Buses in High-Occupancy Vehicle (HOV) Lanes
- 3. Buses in Transitways
- 4. Buses in Fixed Guideway

• Fixed Guide Transit (FGT) Family

- 1. Automated Guideway Transit
- 2. Rail Transit
- 3. Passenger Railroads
- 4. Advanced Guideway Systems

Characteristics of each type technology are described along with various implementation options, photographs, and key points applicable to the I-70 Mountain Corridor. This paper attempts to initially screen these options.

The difficult mountain terrain traversed by the I-70 Mountain Corridor limits the performance of many transit technologies. Vehicles must operate up and down 6% grades, follow tight highway curvature, operate unobtrusively in a spectacular mountain setting, fit within a narrow highway right-of-way, and not significantly degrade the environment while also providing a serious alternative to highway expansion. The I-70 route is long and mostly rural or wilderness in character, which limits typical urban solutions.

A total of eight general technologies were found to meet the broad requirements for operation in the corridor. Many of them have at least some potential to truly provide a cost effective, environmentally friendly transit alternative.



RUBBER TIRE TRANSIT FAMILY

This section reviews various groups of RTT alternatives as well as options within each alternative. Options to utilize buses in the I-70 Mountain Corridor consist of a number of separate configurations of infrastructure and rolling stock. In this report the term "bus" is defined to mean any self-powered vehicle designed for commercial use and capable of operating on state roads carrying in excess of six passengers. Fuel may be diesel, gasoline, compressed natural gas (CNG), propane, or other available alternates. Buses using electric propulsion are "electric trolley buses" and are commonly referred to as "ETB." In addition, buses that use a combination of self-generated fuel and electric propulsion are "Hybrid Electric Buses" or "HEB."

In this report, four basic methods in which to operate buses will be explored. They are:

- 1. Buses in Mixed Traffic
- 2. Buses in High-Occupancy Vehicle (HOV) Lanes
- 3. Buses in Transitways
- 4. Buses in Guideway

Operation in Mixed Traffic means the bus is commingled with regular traffic on I-70. High Occupancy Vehicle (HOV) lanes refer to special traffic lanes that are intended for buses, car pools, and any vehicle carrying a minimum number of passengers set by the HOV operator (usually 2 or 3). HOV lanes may be either a regular highway lane distinguished with specially painted lines, symbols, and signage or a segregated roadway with its own access ramps. A transitway is a completely separate roadway limited to transit vehicles only. It may contain special bus guide rails to reduce lane width requirements and help speed operations.

Each of the scenarios that follow has significantly differing capital costs, operating costs, running times, and capacity limitations. Examples of each of these systems are currently available and in operation somewhere in the world.

Bus in Mixed Traffic

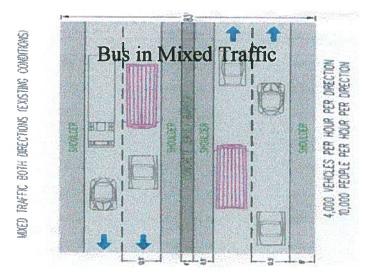
This alternative would use buses operating within the general traffic lanes of I-70 to provide additional highway traffic capacity. The additional highway capacity is obtained by using the buses as a replacement for numerous automobiles, thus freeing up lane space. See figure 1.

Buses could operate from pick-up/drop-off points in Denver or from specially built Park & Ride lots near the entrances to I-70. The capacity of this alternative is essentially tied to the capacity of the I-70 highway lanes. The buses would have no lane priority therefore speeds would be limited by traffic conditions. The buses would also operate slowly on the numerous grades on I-70 as typical available engine output limits the horsepower available.

The types of bus vehicles that could be used include standard 40-foot coaches, tractor-pulled units, articulated sets, or double-deckers. Either diesel fueled or alternate fueled power plants can be utilized. Smaller buses and van operations could also be used as a supplement to the service.



This is a typical suburban or over-the-road bus-operating scenario with examples available in any large metropolitan area. Some of the services described above are already being provided on a much smaller scale within the corridor.





Bus in HOV Lanes

There are two basic options for buses in HOV lanes. One is to separate the lane(s) from general traffic through special lane painting and marking. The second is a lane(s) separated from general traffic through the use of physical barriers (some times using concrete barriers called "Jersey Barriers."

Marked Lanes

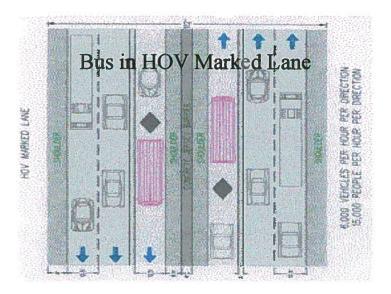
This alternative would add a third lane to I-70 in each direction. The lane would be restricted to High Occupancy Vehicles (HOV) such as buses, vans, and automobiles carrying at least 3 persons. A simple paint stripe and signage would separate the HOV lane from adjacent traffic. See figure 2.

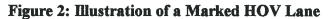
Bus service would operate similarly to the system described in the mixed bus section except that once the buses enter I-70 they would move to the inside HOV lane and travel to their destination with presumably less congestion than in the regular travel lanes. Congestion at interchanges would still be a factor, as would difficulties maintaining speed on grades. In addition, due to the existing high passenger occupancy levels per automobile on this corridor, so many vehicles would qualify for the HOV lanes that any travel advantage might be minimal. Continuous enforcement of the 3-person limit would be required and add to the operating costs of this alternative.

Body style and propulsion types described in earlier are also applicable to this alternative. ETBs cannot be used due to the multiple crossover movements required to access the inside HOV lane.



The eastbound and westbound HOV lanes could be operated as restricted to HOV qualified traffic at all times or only in the peak direction, with the opposite direction HOV lane opened for general use.





Segregated Lanes

In this option, the HOV lanes would be built as a separate highway facility, either in the median of I-70 or as a parallel roadway. A median barrier would completely separate this facility from the general highway lanes. Bus body style and propulsion types described in earlier for mixed traffic buses are applicable to this alternative. ETBs and HEBs could be used due to the separate interchanges, but high speed running in mixed traffic has not been tested for this option. The appearance of the overhead wires could be a problem. See figures 3 and 4 for illustrations of segregated lanes and an electronic trolley bus.

The segregated lanes require less HOV enforcement effort and are less affected by adjacent lane traffic problems. Diesel buses would operate slowly on the grades as engine output limits the horsepower available.

Bus service would operate similarly to the system described in the mixed bus section except that the buses would enter and leave the HOV lanes at special interchanges. They would travel to their destination with presumably less congestion than in the regular travel lanes. Congestion at regular interchanges would not be a factor, but difficulties maintaining speed on grades would still be a problem. As with the "marked lanes", due to the existing high passenger occupancy levels per automobile on this corridor, so many vehicles would qualify for the HOV lanes that any travel advantage might be minimal. Enforcement of the 3-person limit would still be required (but at a significantly less level due to the restricted entry points) and will add to the operating costs of this alternative.

A single pair of HOV lanes can be set to operate only in the peak direction as dictated by demand. This option requires considerable daily maintenance to clear and reverse the lanes, but keeps highway right-of-way use to a minimum. This scenario would require HEBs to return in mixed in traffic, without the electric power advantage on the grades.

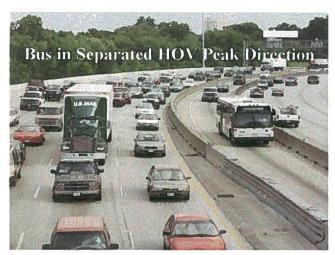


Figure 3: Illustration of Segregated HOV Lane-Peak Direction

Figure 4: Photo of Electric Trolley Bus



Marcopolo double-articulated bus/trolleybus body - rear view



1999/0043494



Bus in Transitway

While somewhat similar to HOV lanes, transitways are exclusive to buses. In HOV treatments, private autos with the requisite number of people can use the facility. In transitways only buses (as defined earlier) can use the facility. See figure 5.

In this option, a separate roadway dedicated just to buses would be constructed in the median of I-70 or as a parallel roadway. With only professionally operated buses traveling at the same speed, only one lane with a shoulder is required. Enforcement would be minimal as Automatic Vehicle Identification (AVI) technology could be used to raise a barrier at the transitway entrances.

Bus service would operate similarly to the system described for mixed traffic except that the buses would enter and leave the transitway at special interchanges. They would travel to their destination with virtually no congestion. For diesel buses, difficulties maintaining speed on grades would still be a problem. Operation of ETBs and HEBs under electric power would be possible and their use would eliminate any slow operation on grades. The use of the overhead wires could be a problem.

A single direction transitway could be set to operate in the peak direction as dictated by demand. This option keeps highway right-of-way use to a minimum. This scenario would require HEBs to return in mixed in traffic, without the electric power advantage on the grades. ETBs could not be used for the return in mixed traffic.

A separate transitway can also be operated like a rail rapid transit system, using stations along the transitway for passenger boarding instead of leaving the transitway and circulating into the community. This scenario is known as Bus Rapid Transit (BRT) and will be an option to be reviewed under the screening.

Bus in Guided Transitway

In this option, a separate roadway dedicated just to special buses with guideway attachments would be constructed in the median of I-70 or as a parallel roadway. With only professionally operated buses traveling at the same speed, only one narrow guideway lane is required for each direction. No enforcement costs would be required, as conventional vehicles could not use the guideway. See figures 6 and 7.

Bus service would operate similarly to the system described for mixed traffic except that the buses would enter and leave the guided transitway at special interchanges. They would travel to their destination with virtually no congestion. For diesel buses, difficulties maintaining speed on grades would still be a problem. Operation of ETBs and HEBs under electric power would be possible and their use would eliminate any slow operation on grades. Due to the presence of the guideway, 3rd rail power pickup for ETBs and HEBs could be used in place of overhead wires.

A single direction guided transitway could be set to operate in the peak direction as dictated by demand. This option keeps highway right-of-way use to a minimum.



Page 6

A guided transitway can also be operated like a rail rapid transit system, using stations along the transitway for passenger boarding instead of having buses leave the transitway and circulating into the community. This scenario is known as Bus Rapid Transit (BRT) and will be an option to be reviewed under the screening phase.

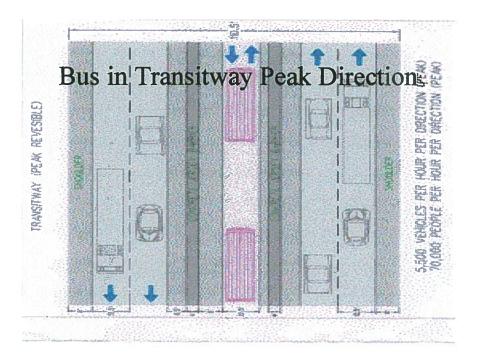


Figure 5: Illustration of a Transitway



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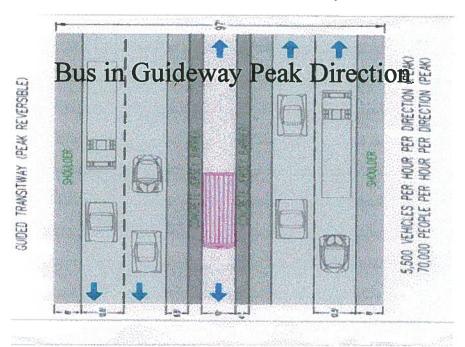


Figure 6: Illustration of Bus Guideway

Figure 7: Illustrations of Guideway Bus







FIXED GUIDEWAY TRANSIT FAMILY

This section reviews various options for fixed guideway transit (FGT). These options include:

- Automated Guideway Transit
- Rail Transit
- Passenger Rail Transit
- Advanced Guideway Systems

Automated Guideway Transit (AGT)

These systems have the common characteristic that they provide service without a human operator. Their guideway therefore must be completely protected to ensure that the automated vehicles cannot contact people, automobiles, or other obstacles in the guideway. For this reason they generally operate only short distances and stay within the definition of an "urban" system. The Federal Railroad Administration (FRA) does not regulate them. They can be operated using conventional rail transit steel wheel vehicles, rubber tires with a guide mechanism, or on a monorail. They are usually differentiated five ways: (1) Where they operate, (2) Whether they can operate outside, (3) Whether they operate with more than one independent vehicle per guideway, (4) Whether they can operate multiple routes, and (5) The propulsion mode of the vehicle.

Automated Guideway Transit systems in airports are often referred to as APM (Airport People Mover) Systems. Automated Guideway Transit systems used for downtown circulation are often referred to as DPM (Downtown People Mover) systems. DPM systems are currently operating in Detroit, MI and Jacksonville, FL. Automated Guideway Transit used in universities (Morgantown), hospital campuses (Duke), amusement parks, and other institutions are usually referred to as either a people mover or by the technology used (i.e., the monorail, the tram, and the shuttle). Automated Guideway Transit systems used for general circulation in an urban area are called ICTS for Intermediate Capacity Transit System. Only one example of this technology exists as an automated operation not exclusively in a downtown area and that is in Vancouver, British Columbia.

Many Automated Guideway Transit systems are operated totally indoors through corridors in buildings. These systems, often found in airports, have far less difficulty providing a safe operating guideway than those operating outside do. In two cases the vehicles used in these indoor systems don't even have ceilings, with lighting provided on the roof of the tunnel. They are located in Houston Intercontinental Airport and the basement of the United States Capitol.

The complexity of Automated Guideway Transit increases substantially when more than one vehicle can operate on the same guideway. Simple cable hauled systems handling only one vehicle per guideway can be operated using common elevator technology. When more than one vehicle is on the guideway, a sophisticated signal system is necessary to provide safe separation between the vehicles and to control braking and acceleration. Obviously, systems that can operate multiple vehicles on a single guideway are more efficient and have a much greater capacity.

Some Automated Guideway Transit systems have the ability to operate on multiple routes on either a preprogrammed schedule or on a demand basis determined by the rider. Preprogrammed systems are referred to as GRT (Group Rapid Transit). Rider demand systems as referred to as PRT (Personal



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I-70 Mountain Corridor PEIS Transit Alternatives

Rapid Transit). Only one true PRT system is in operation at this time. It is an experimental system built in 1974 in Morgantown, West Virginia. It provides service to a large university campus and connects it to downtown Morgantown. Riders select their destination like floors on an elevator. Each small car carries the rider and accompanying parties directly to the station desired, bypassing any other station along the way.

Automated Guideway Transit can be powered by electric traction, cable hauled, or utilize linear induction motors. Sometimes Automated Guideway Systems are characterized by their vehicle capacity. Small systems can be referred to (inaccurately) as PRT systems, larger vehicles as GRT systems, and full size subway-like vehicles as ICTS.

AGT using Conventional Rail

This type of system is currently in operation in Vancouver, British Columbia. A manned version is also in operation in suburban Toronto, Ontario. The linear induction motors in use allow quick acceleration, but can be noisy. See figure 8.



Figure 8: Automated Guideway Transit—Conventional Rail



AGT using Monorail

This type of system is currently in operation at Downtown Jacksonville, FL and the Newark, NJ Airport. See figure 9.



Figure 9: Automated Guideway Transit - Monorail

Rail Transit

Options to utilize rail transit in the I-70 Mountain Corridor consist of either light rail or heavy rail transit systems. Each type of system can be constructed as a double-track line or as a single-track line with passing sidings. Either electric or diesel propulsion systems are available. The tracks can be located in the median of I-70 or on a parallel alignment, diverging only for heavy grades and to serve off line stations. In this report the term "Rail Transit" is defined to mean any conventional rail vehicle designed to operate on tracks not connected to the national railroad network. These systems, when operated in an "urban" area, are exempt from Federal Railroad Administration (FRA) regulation.

Rail Transit vehicles may self-generate their own power or utilize electric propulsion. The term "DMU" refers to light rail Diesel Multiple Unit vehicles that can be operated on non-electrified lines that are not regulated by the FRA. Generally, Light Rail Transit (LRT) and Heavy Rail Transit (HRT) systems utilize electric propulsion. LRT vehicles can, if necessary, operate on tracks in city streets with motor vehicle traffic. Light rail trains could also operate in mixed traffic through the Eisenhower Tunnel to avoid separate transit tunnel costs.

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High capacity HRT systems must operate only on exclusive rights-of-way due to their large vehicle size, long train lengths, their inability to brake and accelerate within motor vehicle tolerances, and (often) the presence of a ground mounted electric third (power) rail. They do have many more options for power pick-up and automation than LRT systems but represent one of the highest costs per mile to construct.

Although examples of long distance rail transit systems can be found in Europe, none are compliant with FRA vehicle safety requirements. The use of this type of equipment in the I-70 Mountain Corridor would depend on whether the FRA considers the system "urban" or if a safety waiver could be obtained.

Light Rail Transit

This type of rail transit system is designed for medium capacity urban and suburban transportation. It differs from Heavy Rail Transit by its ability to operate in mixed street traffic if desired. These vehicles meet all highway operating standards for braking, acceleration, directional turn signals, and sight distances from the operators position. Usually, though, these systems are operated on either a reserved roadway median or an exclusive right-of-way. Their flexibility to operate in many environments and lower initial costs than Heavy Rail Transit has made them the fastest growing rail transit mode in the nation, with over ten new systems being opened in the last twenty years. See figure 10.

Although typically operated using a 600V-700V DC overhead wire, diesel propulsion and 3rd rail versions are also available. Vehicles can utilize low level or high level boarding platforms and are ADA accessible. Newer low-floor versions are also available to speed street level boarding. Vehicles are available from many suppliers.

Light Rail Transit cars are usually 75 - 90 feet long and often operate in train lengths of one to five cars. Train length is typically limited by the street block size when operating in mixed traffic, to avoid blocking intersections. The vehicle width is smaller than Passenger Railroad systems (typically 8.5 feet) to be able to operate on roadways.





Figure 10: Light Rail

Heavy Rail Transit

This type of rail transit system is designed for high capacity urban and suburban transportation. It differs from Light Rail Transit by its requirement for an exclusive right-of-way. These trains are too big and long to operate on highways and the operator cannot see nor brake sufficiently to deal with typical highway maneuvers. Heavy Rail Transit vehicles are capable of high acceleration and are one of the few modes in this report with sufficient power to operate over the I-70 grades at full speed. The PATCO system in Philadelphia currently operates over a 6% gradient on either side of the Ben Franklin Bridge. The BART system in San Francisco uses high performance motors that will out-accelerate an automobile with a ten-car train. See figure 11.

Although typically operated using a 600V-700V DC 3rd rail, diesel propulsion and overhead catenary versions are also available. Vehicles utilize high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Vehicles are available from many suppliers.

Heavy Rail Transit cars are usually 70 - 90 feet long and often operate in train lengths of two to twelve cars. The vehicle width is sometimes smaller than Passenger Railroad systems but cars can be built to their standards if desired.





Figure 11: Heavy Rail

Passenger Railroads

Options to utilize Passenger Railroads in the I-70 Mountain Corridor consist of two separate configurations. In this report the term "Passenger Railroads" is defined to mean any conventional rail vehicle operating on track connected to the national railroad network. These systems are regulated by the Federal Railroad Administration (FRA).

Passenger Rail trains operate throughout the United States. All of these systems share many similarities since they must comply with various construction standards and operating regulations promulgated by the FRA. When operated between a major city and its suburbs the service is referred to as "Commuter Rail." When operated between major cities the service is referred to "Intercity Rail." Amtrak operates virtually all-intercity trains in the United States.

Intercity trains are further subdivided into Short Haul and Long Haul service. Short Haul trains are almost always day trains operating between cities less than 500 miles apart. Long Haul trains operate overnight and many travel across the entire country. Equipment configuration differs between Commuter Rail, Short Haul Intercity trains, and Long Haul Intercity trains. Commuter Rail trains have fairly constricted seating designed for short trips. Short Haul Intercity trains are more generous with seating space and usually provide food service. Long Haul Intercity trains provide seating with leg rests and deep reclines for overnight trips as well as full dining car service, lounge cars, and sleeping room cars.



I-70 Mountain Corridor PEIS Transit Alternatives

A variant of Short Haul Intercity train service is High Speed Rail. These trains operate at very high speeds (over 125 mph) for premium fares. Only one system currently exists in the United States. It is currently in service in between Washington, New York, and (soon) Boston. Dozens of other states as also planning High-Speed Rail systems, with California and the Midwest (centered on Chicago) in the most advanced state. High Speed Rail systems require a straight, flat trackbed to achieve their speed goals and attendant ride quality.

Diesel locomotives or electric locomotives may haul passenger Rail trains. The trains may also be made up of multiple unit cars, each with their own diesel or electric traction motor(s). Electric power can be delivered through overhead catenary wires or a third (power) rail. Conventional railroad trains are limited to a maximum gradient of about 6%, although they are usually designed to operate with only a maximum of a 2% grade on most mainlines, with some exceptions. These systems are very flexible, as they are able to operate on both new alignments as well as existing trackage shared with freight trains.

Locomotive Hauled Trains

This option would provide rail service using existing trackage from Denver Union Terminal to Golden and then over a new alignment to the I-70 Corridor. The new tracks would run parallel to I-70 to Dotsero and then rejoin existing trackage that leads to Glenwood Springs and Grand Junction. The grades on this line would require use of a number of diesel locomotives to power each train in order to be able to traverse the grades in a reasonable period of time.

Electric locomotives could also be utilized to mitigate the grade problem and help maintain air quality standards. Overhead catenary would be necessary but could be designed to minimize visual impacts. 3^{rd} rail systems could also be utilized but would require a completely separate, fenced right-of-way to avoid any dangers to trespassers and wildlife (although under running type 3^{rd} rail is far less accessible than the exposed overrunning type. Due to the distance, 25,000V AC overhead wire systems are the most efficient. 600-700V DC 3^{rd} rail systems could also be used with frequent substations necessary along with a continuous high voltage feeder system.

Passenger Rail trains can utilize either low level or high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Locomotives and cars are available from many suppliers.

Passenger Rail train cars are 85 feet long, 10.5 feet wide and can be operated in trains as long as 20 cars. Cars can either be single deck (13.5 feet high) or double deck (16.2 feet high).

Multiple Unit Trains

This option would provide rail service using existing trackage from Denver Union Terminal to Golden and then over a new alignment to the I-70 Corridor. The new tracks would run parallel to I-70 to Dotsero and then rejoin existing trackage that leads to Glenwood Springs and Grand Junction.

Diesel powered and electric powered multiple unit trains could be used to provide service along this line. Multiple unit trains have a power advantage in that every car has its own driving motors. See figure 12. Overhead catenary would be necessary but could be designed to minimize visual impacts. 3rd rail systems could also be utilized but would require a completely separate, fenced right-of-way Page 15



to avoid any dangers to trespassers and wildlife (although under running type 3^{rd} rail is far less accessible than the exposed overrunning type). Due to the distance, 25,000V AC overhead wire systems are the most efficient. 600-700V DC 3^{rd} rail systems could also be used with frequent substations necessary along with a continuous high voltage feeder system.

Passenger Rail multiple unit trains can utilize either low level or high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Multiple unit cars are available from many suppliers.

Passenger Rail multiple unit train cars are 85 feet long, 10.5 feet wide and can be operated in trains as long as 20 cars. Cars can either be single deck (13.5 feet high) or double deck (16.2 feet high).



Figure 12: Multiple Unit Train

Advanced Guideway Systems

For the over hundred years there have been only two realistic modes in use for ground transportation: railway (urban and passenger) and highway. In the last twenty years research has been closing in on two types of magnetic levitation (maglev) systems that can be used for a new generation of high speed ground transportation. In addition, an older mode primarily used for transit applications, the monorail, has been proposed in various forms for higher speed intercity service.

The major advantage of both the maglev and monorail technologies is speed. Running times could be significantly shortened, but the infrastructure necessary to accomplish this time saving may mean significant new right-of-way acquisition. These Advanced Guideway Systems need right-of-way that is basically straight. Curve limitations will challenge the use of the I-70 Mountain Corridor for most high speed conventional rail, monorail, or maglev systems.



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Monorail Systems

The monorail concept utilizes a single elevated beam to carry a train over any ground-based obstructions. Vehicles can ride above the beam, hang from the beam, or run astride of the beam. The concept has been in operation since the 1950s in amusement parks, downtown circulators, and airport AGT systems. In Japan, some monorail systems are used between downtown areas and airports. See figure 13.

Monorails are operated essentially as Heavy Rail Transit since they are grade separated and cannot run in mixed traffic. They have most of the attributes and limitations of Heavy Rail Transit, but have not been proven in a corridor as long or as remote as the I-70 Mountain Corridor.

A monorail system would need a circulation system at each end of the trip to provide reasonable access. Propulsion for the trains is electric using either conventional electric traction motors or a proposed linear induction motor system. Vehicles can be operated using rubber tires or steel wheels.

Magnetic Levitation Systems

Maglev systems have been under development since the 1960s. Two types are being actively tested. A German attraction based design where the magnets on the track are attracted to electromagnets on the car, which are used to levitate the car for high speed running. Also a Japanese repulsion based design where the magnets on the track push the car away to levitate it in a trough for high speed running.

The German design, which was being planned for a new line from Berlin to Hamburg, was recently defunded. The Japanese design is still undergoing full scale testing in a section of the planned track built outside of Tokyo.



Figure 13: Monorail





Appendix C TranSystems I-70 Mountain Corridor PEIS Level 2 Screening June 2001 This page intentionally left blank.

I-70 Mountain Corridor PEIS Level 2 Screening

Prepared for:

Colorado Department of Transportation

J.F. Sato & Associates, Inc.





Prepared by:



Draft

June 2001



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- C. FGT and RTT Electrification Costs
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Section I

Summary

INTRODUCTION

The Level 2 Screening process is part of the effort of the Programmatic Environmental Impact Statement (PEIS) effort to select a Locally Preferred Alternative for increasing capacity in the I-70 Corridor between the Denver Metro area (generally starting in the vicinity of the intersection of I-70 and I-470) and Vail. The Level 2 process started with the alternatives recommended for further analysis in the Draft Final Report on Transit Alternatives (May, 2000), the Level 1 Screening process. This section will act as a roadmap to find information in the attached report.

PURPOSE AND SCOPE

The purpose of the Level 2 Screening process was to develop the data required to make an informed decision on refining/reducing the number of transit alternatives carried forward for detailed analysis for selection as the Locally Preferred Alternative in the PEIS. There are two general categories of alternatives that were analyzed:

Fixed Guideway Transit (FGT)

This family integrated the subcategories of Automated Guideway Transit, Rail Transit, Passenger Railroads and Advanced Guideway Systems identified in the Draft Final Report on Transit Alternatives (May, 2000). Both single track (with passing sidings) and double track alternatives were considered for all the conventional technology systems operating in the corridor. Because of the very real differences in the ability of modes to operate on different grades, along with the widely varying capital costs, the FGT systems were evaluated on alignments with various maximum grades. A conventional monorail, powered by electric traction motors, was tested on three different alignments as well as the Colorado Intermountain Fixed Guideway Authority (CIFGA) monorail concept (based on linear induction motor power) using anticipated performance data provided by CIFGA. Two alternatives for operation of diesel locomotive-hauled passenger railroad service on the Union Pacific route via the Moffat Tunnel were also evaluated.

The FGT alternatives that were analyzed (with the maximum grades of the alignments that were tested) are listed below:

- 1a Diesel Light Rail Transit, single track-4%
- 1b Diesel Light Rail Transit, single track-6%
- 1c Diesel Light Rail Transit, single track-Hwy
- 2a Diesel Light Rail Transit, double track-4%
- 2b Diesel Light Rail Transit, double track-6%
- 2c Diesel Light Rail Transit, double track-Hwy
- 3a Electric Light Rail Transit, single track-4%
- 3b Electric Light Rail Transit, single track-6%
- 3c Electric Light Rail Transit, single track-Hwy
- 4a Electric Light Rail Transit, double track-4%

- 4b Electric Light Rail Transit, double track-6%
- 4c Electric Light Rail Transit, double track-Hwy
- 5a Diesel Heavy Rail Transit, single track-4%
- 5b Diesel Heavy Rail Transit, single track-6%
- 6a Diesel Heavy Rail Transit, double track-4%
- 6b Diesel Heavy Rail Transit, double track-6%
- 7a Electric Heavy Rail Transit, single track-4%
- 7b Electric Heavy Rail Transit, single track-6%
- 8a Electric Heavy Rail Transit, double track-4%
- 8b Electric Heavy Rail Transit, double track-6%
- 9a Diesel Locomotive hauled Passenger RR, single track-4%
- 9b Diesel Locomotive hauled Passenger RR, single track-6%
- 10a Diesel Locomotive hauled Passenger RR, double track-4%
- 10b Diesel Locomotive hauled Passenger RR, double track-6%
- 11a Electric Locomotive hauled Passenger RR, single track-4%
- 11b Electric Locomotive hauled Passenger RR, single track-6%
- 12a Electric Locomotive hauled Passenger RR, double track-4%
- 12b Electric Locomotive hauled Passenger RR, double track-6%
- 13a Electric Multiple Unit Passenger RR, single track-4%
- 13b Electric Multiple Unit Passenger RR, single track-6%
- 14a Electric Multiple Unit Passenger RR, double track-4%
- 14b Electric Multiple Unit Passenger RR, double track-6%
- 15a Electric Conventional Monorail Advanced Guideway System, double guideway-4%
- 15b Electric Conventional Monorail Advanced Guideway System, double guideway-6%
- 15c Electric Conventional Monorail Advanced Guideway System, double guideway-Hwy
- 16 CIFGA Monorail (Highway only)
- 17 Moffat Tunnel to Winter Pk. Diesel Locomotive hauled Passenger RR
- 18 Moffat Tunnel to Glenwood Diesel Locomotive hauled Passenger RR

Rubber-Tired Transit (RTT)

This family includes Diesel Bus (DB), Electric Bus (EB) which draw electric power from external sources through overhead catenary wire or guideway-mounted power rails, and Dual Mode Bus (DM) (previously termed Hybrid Electric Bus-HEB) capable of self-propulsion using an on-board diesel engine or operating with electric power like an EB. DB and DM buses were evaluated with operation on transitways and guideways in both the peak direction only (with return via mixed traffic in the regular highway lanes), as well as with versions operating in both directions. This option is not appropriate for EB because it is not feasible to operate from electric power wires over general use expressway lanes. In addition, a version for each technology was tested with Bus Rapid Transit (BRT) stations along the alignment, allowing buses to serve, at least, some points without leaving the line.

The RTT alternatives that were analyzed are listed below:

- 1 Bus and Improved Van in mixed traffic
- 2 Diesel Bus in marked HOV lane, peak

- 3 Diesel Bus in marked HOV lane, both
- 4 Diesel Bus in separated HOV Lanes, peak
- 5 Diesel Bus in separate transitway, peak
- 6 Diesel Bus in separate transitway, both
- 7 Diesel Bus in guided transitway, peak
- 8 Diesel Bus in guided transitway, both
- 9 Diesel Bus in guided transitway, both, BRT stations
- 10 Dual Mode Bus in separate transitway, peak
- 11 Dual Mode Bus in separate transitway, both
- 12 Dual Mode Bus in guided transitway, peak
- 13 Dual Mode Bus in guided transitway, both
- 14 Dual Mode Bus in guided transitway, both, BRT stations
- 15 Electric Bus in separate transitway, both
- 16 Electric Bus in guided transitway, both
- 17 Electric Bus in guided transitway, both, BRT stations

The criteria that were utilized in the analysis are described in Appendix A. While FGT and RTT alternatives were not directly compared, the same criteria and rating scheme was used. This will facilitate future cross-modal comparisons. Other environmental criteria were evaluated separately, and are not shown in this document.

The following sections of this report are key descriptive explanations that are important for understanding the methodology used.

- II. FGT Operating Plan
- III. RTT Operating Plan
- IV. Train Performance Calculator (used to calculate average speed for FGT alternatives and Energy Consumption; which are also inputs to cost models)

The rating of each alternative for each of the criteria is contained in the following Tables:

- 1. Evaluation Matrix FGT Alternatives (complete tabulation ratings and discussion of non-quantitative criteria)
- 2. Evaluation Matrix RTT Alternatives (complete tabulation ratings and discussion of non-quantitative criteria)
- 3. FGT Analysis Results (contains backup data for quantitative elements; System Capacity, Capital Costs and Energy Consumption)
- 4. RTT Analysis Results (contains backup data for quantitative elements; System Capacity, Capital Costs and Energy Consumption)

More detailed background information, in tabular form, is contained in the following Appendices:

- A. Criteria and assumptions for FGT/RTT Level 2 Screening Process
- B. Types of FGT Equipment Tested
- C. FGT Electrification Costs
- D. Feeder Bus Operations Summary

METHODOLOGY

A five level scheme was utilized for the rating of each alternative for each of the criteria. The levels used are:

- 1 Highest/Best
- 2 Best to Intermediate
- 3 Intermediate
- 4 Worst to Intermediate
- 5 Lowest/Worst

RESULTS AND FINDINGS

Summary sheets showing the ratings of all the tested alternatives follow.

FGT

Use of the Train Performance Calculator (TPC) confirmed that the difficult mountain terrain traversed by the I-70 Mountain Corridor limits the performance of many transit technologies. Vehicles were tested on alignments with maximum grades of 4%, 6% and, in some cases, the I-70 highway alignment (with a maximum grade of about 6.7%). Specifically, the expectation of the Level 1 Report that locomotive-hauled trains are not appropriate was borne out. The single-track alternatives were found to have inadequate capacity to serve as a viable approach to providing enough additional capacity to significantly relieve congestion on I-70. The diesel Heavy Rail Transit (HRT) alternatives were found to be unable to meet the minimum average speed requirements.

The remaining technology alternatives were able to perform adequately on the 6% or highway alignment. Thus, the 4% alignment alternatives, with their high costs due to major tunneling requirements, would not be needed.

The alternatives that are recommended to continue into the next phase are:

Diesel Light Rail Transit, double track-Highway Electric Light Rail Transit, double track-Highway Electric Heavy Rail Transit, double track-6% Electric Multiple Unit Passenger RR, double track-6% Electric Conventional Monorail Advanced Guideway System, double guideway-Highway CIFGA Monorail-Highway.

RTT

Improved Bus/Van service in mixed traffic was screened out because its capacity and speed are too low to have a significant impact on I-70 congestion. Electric only buses were screened out because of their inability to provide through service either into the Denver Metro area or to points off the transitway in the Corridor. Bi-directional transitway alternatives without BRT stations (requiring buses to leave the transitway to reach all stations) were screened out because the topography of the I-70 communities allows the use of on-line stations without community access limitations. Peak direction only versions of the transitway were screened out because they take up almost as much right-of-way width as the more flexible bi-directional versions. Because of the advantage of BRT stations, all bi-directional transitway alternatives that continue will be assumed to utilize this design feature.

The alternatives that are recommended to continue into the next phase are:

Diesel Bus in separate transitway, both directions, BRT stations Dual Mode Bus in separate transitway, both directions, BRT stations Diesel Bus in guided transitway, peak direction Diesel Bus in guided transitway, both directions, BRT stations Dual Mode Bus in guided transitway, peak direction Dual Mode Bus in guided transitway, both directions, BRT stations.

Diesel Buses will be assumed to be 45-foot buses (because of the inability of equipping an articulated diesel bus with a reasonably powerful enough engine to maintain high speeds on the long grades with full loads and acceptable noise levels). Dual Mode buses will be assumed to be 60-foot, articulated buses.

In the next Level of screening the most viable existing technology and promising new technology will be identified for further evaluation against other highway improvement options.

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Passenger Railroad - Glenwood Springs Service*	1400			28.7					
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Alternative screened because the same technology performs similarly with less cost under a different alignment

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I-70 Mountain Corridor PEIS Screening & Summary Analysis of Fixed Guideway Transit Alternatives

Rubber Tire Transit Alternatives

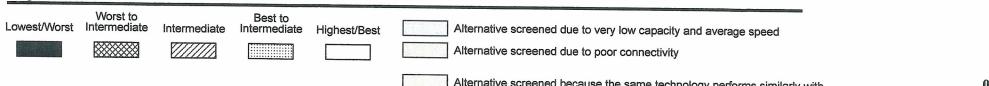
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	Cáp	stem acity hour)	System Attractiveness	Aver Spe			Feeder/ Distribution Requirements		Capital Costs (infrastructure
Direction	Est.	Rating		Estimated MPH	Rating	systems)		eachother)	and rolling stock)

Diesel Bus	Both/BRT	24,000		51	///////////////////////////////////////
Dual Mode Bus (Diesel/Electric)	Both/BRT	32,000		60	V/////////////////////////////////////
Guideway					
• Diesel Bus	Peak	24,000		51	
	Both/BRT	24,000	V/////////////////////////////////////	53	
Dual Mode Bus (Diesel/Electric)	Peak	32,000		60	
	Both/BRT	32,000		64	

Bus/Van in Mixed Traffic*	Deth	1			2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	
	Both			36	888888888	
Transitway			-			
Diesel Bus	Peak	24,000	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	51		
Dual Mode Bus (Diesel/Electric)	Peak	32,000	V/////////////////////////////////////	60		
Electric Bus	Both	32,000		60		
Guideway						
Diesel Bus	Both	24,000		51		X/////////////////////////////////////
Dual Mode Bus (Diesel/Electric)	Both	32,000		64		X/////////X///////////////////////////
Electric Bus	Both	32,000		60		
	Both/BRT	32,000	V/////////////////////////////////////	64		

*Transferred to Transportation Management Family for further evaluation

Legend



Alternative screened because the same technology performs similarly with less cost under a different version

06/06/01

		entation		
re	Technology Available	Fu Usa	iel age	Energy Consumption (cost/seat mile)
		Avail.	Limit	
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I-70 Mountain Corridor PEIS Screening & Summary Analysis of Rubber Tire Transit Alternatives



Section II

FGT Operating Plan

MEMORANDUM

Date:	June 6, 2001
To:	Gary Johnson, William Stringfellow, Mark Walbrun, Ted Rieck
From:	David Phillips
Subject:	CONCEPTUAL FIXED GUIDEWAY TRANSIT OPERATIONS PLAN

This briefly documents the Mountain Corridor FGT conceptual operations plan. The purpose of the plan is to assist in the second level screening by providing a basis for grading the various alternatives against the criteria. This memorandum discusses the elements of the operations plan, key assumptions, as well as provides a summary of the plan to date. This plan is based on a conceptual level of analysis. Key assumptions are summarized in Appendix A.

This is a plan for operation of a mainline, trunk FGT system linking DUT and DIA in Denver with Vail (Town Center/Exit 176). Intermediate stops in the corridor will be at stations previously identified (Evergreen area, Idaho Springs, Empire, Loveland Pass, Keystone (for the 4% alignment that does not go through the Eisenhower Tunnels), Silverthorn, Frisco and Copper Mountain). All trains will operate through from DIA to Vail, stopping at DUT. Based on the preliminary ridership statistics, there is very little dropoff in ridership along the route, thus it is not appropriate to have any trains terminate at short destinations. Capital costs are figured only for the portion west of the connection with the Gold Line, east of Golden.

Connectivity

It is assumed that the connection to DUT and DIA will be over routes previously identified as the Locally Preferred Alternative (LPA) in the I-70 West (Denver to Golden) and the Denver to DIA Major Investment Studies (MIS). Connection with the Gold Line will be at a station point on the BNSF Railroad called Mt. Olivet, east of Golden. It is assumed that Mountain Corridor trains would not carry local passengers whose entire journey is east of Golden. The actual Golden stop might be located close to I-70, where a large Park and Ride lot could be constructed (as shown as Option 2 in the Gold Corridor MIS). It is assumed that the Gold Line and the DUT to DIA segments will be built so as to be able to accommodate through running of trains of the technology selected for the Mountain corridor, if rail is selected. This, principally, means that the decision on whether these lines are built as non-FRA compliant or FRA-compliant rail routes would be dependent on the Mountain Corridor's selection. Similarly, if the Mountain Corridor selects electrically-powered trains, it is assumed that the DUT-DIA Line (where non-FRA compliant DMUs were selected as the LPA) would be electrified. It is assumed that both lines would be built as double track routes. It is assumed that Advanced Guideway Systems (AGS) alternatives would require a transfer to the presently planned Gold Line LRT. No construction costs east of Golden are included, although it is apparent that there would be some differences between modal alternatives.

Specifically, there is the possibility that an additional (third) track might be required between Golden and DUT because of the number of local stops planned for Gold Line Trains. Mountain Corridor trains would operate nonstop in this segment, with passengers from these stops transferring to Mountain Corridor trains at Golden.

At the West end of the Corridor, it is assumed that DMU service is operated between Vail (at a joint station) and the Eagle Airport passenger terminals. This would operate over the presently-unused portion of Union Pacific (ex-D&RGW) Tennessee Pass line between Eagle and Dowds Junction, a new line (of about one mile) connecting to the airport passenger terminals and a new line (of about 5 miles, essentially in the I-70 corridor) between Dowds Junction and Vail. All alternatives with diesel/turbine-powered trains for the Mountain Corridor will be assumed to provide through (no transfer) service to Eagle; alternatives with electrically powered trains would require passengers to make a same platform transfer. No costs for construction or operation of the Intermountain Connection are included.

Feeder/Distribution Requirements

It is assumed that the distribution system in the corridor would be the same as the one developed for the RTT system. It is anticipated that most of this distribution network is in place and may only need to be augmented to support the trunk system. Since this is identical for the all FGT alternatives no analysis will be performed for FGT. The exceptions are the recently added alternatives using the Moffat Tunnel route, which do not serve any of the I-70 Corridor to Vail. Implementing this service would essentially imply creating the mixed traffic version of the RTT network. This major difference will be noted by rating the Moffat routes as "Low" and all the other FGT alternatives as "High."

Average Speed

Average speed was calculated using Railsim 7[®] Train Performance Calculator (TPC) software operating each equipment type over the 4% and 6% preliminary alignments (light rail was also tested on the existing "highway" alignment). This software also identified equipment that cannot successfully operate on the grades of the Corridor (principally on the 6% alignment). Several candidates from the Railsim 7[®] rolling stock library of each train type were run through the TPC with the best chosen to represent the alternative. See Section IV for a more detailed discussion of this methodology.

Service Levels

Service will be assumed to operate in both directions from about 5:00 a.m. to 11:00 p.m., seven days per week every day of the year. The following table summarizes proposed key operating features of the trunk FGT network based on preliminary ridership data and typical train capacities. Light rail, with its limited train length, is anticipated to operate double the number of trains (half these headways). Note that the holiday peak headways would only require to be operated in one direction. On the single track alternatives returning cars would be added to the trains in the reverse peak direction, operating every 20 minutes, will return the additional cars required by the 10 minutes peak direction headway.

		he	adways			
Day Type	Days per year	First & last 2 hours (4 total)	Balance (14 hours)	Peak hour peak direction one-way number of trips	All day one- way number of trips	
Normal	265	30 min	30 min	2	37	
Peak	75	30 min	20 min	3	51	
Holiday peak	25	20 min	6hrs @10min 8hrs @20min	6	85	

Capacity

Capacity of alternatives was calculated based on the scheduled headways in the peak periods on holiday peak days. Because of the long trip length, it is assumed that seats are provided for all passengers. All cars are assumed to have rest room facilities and a 10% allowance for food service facilities on all alternatives except LRT and AGS. The target is the ability to accommodate peak hour, peak direction flows of 4200 passengers. For Second Level Screening we are assuming that ridership will be essentially constant over the course of the 50 years of the design life of the system. It is assumed that there will be passing sidings (or second main track) at all stations and at additional points. It is assumed that the closest feasible passing siding spacing is about every four miles; closer than that it would probably be more economical to install and maintain double-track. It has been calculated that this would provide capacity on single-track alternatives to operate 10-minute headways in the peak direction and 20 minutes in the opposite direction. Theoretical capacity on a long double track line such as this has been calculated at 5-minute headways. Capacity for AGS conventional monorail alternatives was calculated at 2-minute headways (as claimed by the manufacturer of the tested system) and, similarly, the CIFGA figure is that provided by CIFGA.

Because of the existing heavy freight traffic on the Moffat Tunnel Route, only one additional trip, operating on the busiest 100 days per year, is assumed. Even this may be difficult to actually operate.

Fare Collection/Crew consists

It has been assumed that station to station fares will be in effect for the Corridor, requiring roving staff to check/collect tickets. This is also appropriate considering the high percentage of occasional users in this Corridor where leisure travel dominates. A crew consisting of a train operator and two conductors has been assumed, except for LRT and the AGS conventional monorail. In the LRT case, it has been necessary to assume one conductor per car, because of the lack of end doors. This prevents a conductor from walking through the train. Food service staff has not been calculated. The small AGS conventional monorail trains have been assumed to only require one conductor.

Other steps

A worksheet was created for each FGT alternative for development of capital and operating costs for this schedule (see Table 3). All equipment types that were run

through the TPC software were identified, including its key characteristics and any adaptations that have been assumed in our testing. Specifically, these worksheets were converted into Table 1 which documents assumed adaptations to capacity that were made (to modify equipment designed for routes with short-distance trips to accommodate longer distance trips with a wider seat pitch and an allowance for food service facilities, except on LRT). The results of the test for each equipment type are also be provided in this table. Running times will be based on the end-to-end running time developed in the TPC. Using the TPC, we identified the equipment types that are most suitable for use in the corridor for each modal alternative, and why.

Table 3 also shows peak vehicle requirements, train miles and full time equivalent (FTE) number of train crew members, and estimated revenue hours. Capital costs are also shown. Capital and operating costs over the 50-year design period were developed. All costs shown are in 2001 dollars.



Section III

RTT Operating Plan

MEMORANDUM

Date: June 6, 2001

To: Gary Johnson, William Stringfellow, Mark Walbrun, David Phillips

From: Ted Rieck

Subject: CONCEPTUAL RUBBER TIRE TRANSIT OPERATIONS PLAN

This briefly documents the RTT conceptual operations plan. The purpose of the plan is to assist in the second level screening by providing a basis for grading the various alternatives against the criteria. This memorandum discusses the elements of the operations plan, key assumptions, as well as provides a summary of the plan to date. This plan is based on a conceptual level of analysis. Key Assumptions are summarized in Appendix A.

This plan will eventually be divided into two parts. The first part is a plan for a mainline, trunk RTT system. This trunk system is intended to link key origins in metropolitan Denver with key destinations in the corridor. The second part (to be developed later) addresses a distribution system in the corridor. It is anticipated that most of this distribution network is in place and may only need to be augmented to support the trunk system. The transit system inventory collected in phase I of the PEIS was used.

The conceptual trunk portion of the plan will serve the basis of service for the varied RTT options. The same basic plan would be used for buses in mixed traffic, buses operating in some kind of HOV, as well as buses in a fixed guideway configuration. The operations and scoring will vary due to technology/operating methodology (e.g., stations for BRT options) and the anticipated operating speed (e.g., low with mixed traffic, high with transitways).

The distribution portion of the plan will be developed after the conceptual trunk system is internally accepted.

General Assumptions

There are four basic assumptions:

There are three main points of origin in metro Denver, each to have its own route. They are Denver International Airport, downtown Denver (16th Street Mall area), and the park and ride at C-470 and I-70 (so-called "hogback". Each origin will have a dedicated service or route connecting it to destinations in the I-70 corridor. Thus, DIA to the corridor would be one distinct route, C- 470 to the corridor another, and, finally, downtown Denver to the corridor. With few exceptions, each route serves a distinct market and it not anticipated that one route would serve more than one origin. For example, the DIA route will not make stops at the C-470 Park and ride area.¹

- There are nine targeted areas or "catchments." Collectively, the dedicated routes will serve these areas. It is anticipated that there will be one stop in the area. A localize distribution system (to be developed later) will take travelers to their final destination. It is anticipated that at high volume destinations, "skycap" type service, day storage and checked through luggage services would be provided.²
- There are three levels of service for each of the three dedicated services. The levels are high (peak), medium (base level service), and low (minimal service). Frequency and/or number of stops in the corridor distinguish each level. Peak service has fewest stops with the highest frequency.
- Most services are planned operate seven days per week, with the C-470 operating six days per week. Services operate from about 5:00 AM to 9:00 PM.

Service	Level	Frequency	Number of Pattern Stops	Days	Span of Operation	Special Features
DIA	Overall			7	5am to 9pm	check through luggage
	High	30	2-3		30101031870175 5 753	
	Medium	60	3-4			
	Low	60	3-4			r.
C-470 Park & Ride	<u>Overall</u>			6	5am to 9pm	"sky cap" at stops
	High	60	3-4			storage at stops
	Medium	60	4			
	Low	60	6			
Downtown Denver	Overall			7	5am to 9pm	"sky cap" at stops
	High	60	4-5		0.0000	storage at stops
	Medium	60	4-6			
	Low	60	9			

Table IIIa: Summary of key operating features of the Trunk Rubber Tire Transit Network

Table IIIb, on page 4, illustrates for each of the three routes the level of service as well as a unique pattern(s). The table is divided into the three main routes or origins (DIA, C-470, and downtown Denver). Also shown are nine (eleven including Avon and Eagle) destinations. It shows three levels of service (high, medium, and low). For each service

¹ Exception would be during low service period where multiple origins could be served. For example, the downtown Denver route might serve C-470 origin during late evening hours.

² This address a key convenience issue raised by corridor bus operators.

level there may one, two or three patterns that serve different combinations of destinations. For example, the DIA route, at the high service level, pattern 1 would stop at Evergreen, Loveland, and end at Keystone. DIA high service, pattern 2 first stops at Silverthorne and then Frisco. Route 3 expresses to Copper before ending at Vail. A fourth pattern for the high service level is for the future stops at Avon and Eagle.

Underlying rationale for the patterns in Table IIIb is based on allowing quick, direct travel during the heaviest travel times. In the lesser travel times, stops become more numerous thus service less quick. Keeping stops and travel time to a minimum is a key consideration.

Table IIIc presents estimated operating statistics for the trunk system at three "speed" levels (again, low, medium and high). The speed levels will be coordinated with the tercile ratings of speed for each alternative. Thus, an alternative in the lowest tercile for speed will have the statistics associated with the "low speed service" section in table IIIc. The statistics illustrated are for each route and level of service, frequency (of individual patterns), designated catchment stops for each pattern, days of operation, span of service, peak vehicle requirement, full time equivalent (FTE) number of bus operators, and estimated revenue hours. The later statistics in the table assumes one bus can handle anticipated demand for each pattern trip. If ridership numbers come in greater than anticipated, multiple buses/trips for each pattern may be needed.

Table 2 shows the detailed evaluation matrix with assigned ratings for each alternative.

					19	Catchmen	t Destinati	on	-			
Origin/Level/Pattern	Origin to C-470	Evergreen	idaho Springs	Georgetown	Loveland	Kevstone	Silverthome	Frisco	Conner	indian indian		
Distance Between Stations Cumulative Distance			20			10 54		1	2	7	19 18 9	9 1 7 11
DIA	30		50		74	84	90		2 9	9 11	8 12	7 14
High	1 2 3				deletetetetetete			2 6	ē.			
Medium	4						¢				illilli.	unn
	1 2 3	9666666	ĺ		89999999					mm	mm	
Low	1	Same	l.		वननननन	Contenting of	Ziscourie (Therapy			1	
	2	PERSERTE			(*11*1.********************************	And the Local Boo		and an other second second	and the states	104 (22884)	ann	xuun
C-470	0		20	32	44	54			2 0		a 91	11
High	1 2							11		ШJ	8	
Medium	1 2				doniacon		mm					,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Low						1115A 1	世界 18	96 112 and	UNIT	- NOILINE		annn
Downtown Denver	15	24	35	47	59	69	75	71		10	Contraction Speed	a productive of the production
High	1 2	5 (12)	强 -]				9 **				
Medium	1				20000000		mm					,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Low		10010350107	e e e e e e e e e e e e e e e e e e e	GEO2017	essessor		anaana	Witch	11 Common		,111111	
Legend:		1. I.	Solid = stop :	served in n	ear and interme	diate tern	1					
		11111111	Diagonal = fu	ture servic	e stop							
			Stop Elimina	ted in the f	uture							
		-[+]+[+[+]+[+]+[+]+]	Stop served o	an a Damas	d Deserves h	2242						

Table IIIb: Rubber Tire Transit Conceptual Trunk Service Design

TableIIIc:

Operating Statistics for Three Service Speeds of Conceptual Trunk Service

Service	Service Level	Frequency	Pattern Stops	Days	Span of Operation	Peak Vehs	Est FTE Veh Operators	Annual Revenue Hours
DIA	Overall			7	5am to 9pm	42	89	153,100
	High	30	2-3		CONTRACTOR OF THE			100,100
	Medium	60	3-4					
	Low	60	3-4					
C-470 P&R	Overall			6	5am to 9pm	11	37	64,500
Construction with	High	60	3-4	12	sam to opin		07	04,000
	Medium	60	4					
	Low	60	6					
Downtown Denver	Overall			7	5am to 9pm	13	39	68,000
	High	60	4-5		sam to opin		00	00,000
	Medium	60	4-6					
	Low	60	9					
Totals						66	166	285,600

Summary: Lowest Tercile Speed

Summary: Medium Tercile Speed

Service	Level	Frequency	Pattern Stops	Days	Span of Operation	Peak Vehs	Est FTE Veh Operators	Annual Revenue Hours
DIA	Overall			7	5am to 9pm	34	72	124,400
	High	30	2-3		19			121,100
	Medium	60	3-4					
	Low	60	3-4					
C-470 P&R	Overall			6	5am to 9pm	9	30	52,400
	High	60	3-4		1			02,400
	Medium	60	4					
	Low	60	6					
Downtown Denver	Overall			7	5am to 9pm	11	32	55,300
	High	60	4-5	29	contro opin		J.	00,000
	Medium	60	4-6					
	Low	60	9					
Totals						54	135	232,100

Summary: High Tercile Speed

Service	Level	Frequency	Pattern Stops	Days	Span of Operation	Peak Vehs	Est FTE Veh Operators	Annual Revenue Hours
DIA	Overall			7	5am to 9pm	29	61	104,832
	High	30	2-3					104,002
	Medium	60	3-4					
	Low	60	3-4					
<u>C-470 P&R</u>	Overall			6	5am to 9pm	8	26	44,157
	High	60	3-4			5		44,107
	Medium	60	4					
	Low	60	6					
Downtown Denver	Overall			7	5am to 9pm	9	27	46,557
	High	60	4-5				-71	40,007
	Medium	60	4-6					
	Low	60	9					
Totals						45	53	195,545

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Section IV

Train Performance Calculator

Train Performance Calculator in PEIS Secondary Screening

Process of Train Performance Calculator

The Railsim 7® Train Performance Calculator (TPC) was utilized to model train performance. This particular Train Performance Calculator has gained the recognition within the industry as one of the most inclusive types being utilized today. The Norfolk Southern Railway has purchased Railsim 7® for use as a planning and costing tool. Railsim 7® is being utilized in a major capacity study between Newark, NJ and Penn Station, New York City for the various stakeholders there.

We utilized the TPC to project performance characteristics of several types of equipment over three different projected FGT alignments (Highway, 6% and 4%) from I-470 to Vail. Only westbound alignments were utilized in Secondary Screening. The TPC was used as a planning tool to:

- verify the capabilities of various technologies of rolling stock on the mountain grades
- ensure support of predicted ridership
- develop trip time predictions for the FGT alignments (required to calculate operating costs and fleet size requirement analyses, a key part of capital costs)
- predict energy consumption (kWh for electrically-powered trains and gallons for diesel-powered trains; kWh was also an input for sizing the electrical distribution system).

We utilized the TPC to compare and analyze the performance and trip times of alternative rolling stock types, including "off-the-shelf" versus custom-built models.

In summary, the TPC was used to generate detailed and highly accurate performance characteristics of a single train operating over a specified alignment. The performance data includes time, distance, velocity and acceleration, among the many types of output.

The TPC's Database Editor was utilized to enter the data for the various alignments (location of grades, curves, tunnels and stations) that collectively describe the profiles. We will be able to verify the effect on the changing performance characteristics of the rolling stock being tested of design changes within a proposed alignment.

The Report Generator function of the TPC summarize performance from the huge "raw" output files (numerous data points are recorded each second of the simulated run (typically two hours long). To date, text-based Train Summary Report have been produced for each run. The report provides an overview of the selected TPC run(s), by station. It includes a header identifying the report and the geographic limits of the run, as well as all option and parameter settings, station arrive and leave or pass times (for non-stop runs) based on cumulative running time from the beginning of the run, as well as distance operated, average velocity (with and without station stops), peak power demand and energy consumption for and End to End run. The TPC can also produce user-specified graphic plot reports.

Summary of Transit Modes Tested

Railsim 7® has an extensive library of rail equipment. There are 344 North American Locomotives, 128 North American Coaches, 64 North American Multiple Unit Cars, 220 North American Transit Vehicles, 292 World Wide Multiple Unit Cars, and 412 World Wide Transit Vehicles. With this roster to choose from, we were able to select the best type of equipment available to match the parameters required for PEIS Secondary Screening.

Where modifications to equipment types in the library were required we constructed custombuilt train sets utilizing the capabilities of the TPC to build "user-defined" rolling stock, based on equipment in the library. Final testing screening for one such train set is shown in the table under the Electric Heavy Rail Transit mode. This approach was also utilized to simulate non-rail systems such as Advanced Guuideway Systems (AGS) and buses (both electric and diesel).

We tested Electric and Diesel Light Rail Transit trains, Electric and Diesel Heavy Rail Transit Cars, Railroad Passenger trains (FRA compatible) pulled both by diesel and electric locomotives, as well as Diesel and Electric Multiple Unit, Monorails and buses (both diesel and electrically-powered). The results are summarized as follows (see Appendix B for a complete presentation of the equipment tested and the simulator results):

<u>Electric Light Rail Transit</u> – This mode was tested on all three alignments (Highway, 6% and 4%). Due to the recent success of Light Rail Transit in the United States (including the new Denver RTD system) and the on-going modernization of existing LRT systems worldwide, there are many choices of equipment available for testing despite the severe grades and curves encountered within these three alignments. Nine different types of equipment were chosen for testing. Selection parameters were high maximum speed and horsepower. We assumed that all equipment tested would require many modifications to increase the existing seating capacity; most of these equipment types have been specified for city transit use, include a heavy reliance on standee less capacity, not appropriate for the long trips in this corridor.

The San Jose Santa Clara VTA 2000 Light Rail Vehicle outperformed the other eight candidates selected for testing. This turned out to be the fastest performance by any of the conventional rail modes, averaging 48.6MPH for a non-stop run and a 1:47 elapsed time over the Highway Alignment. Several others were close.

<u>Diesel Light Rail Transit</u> – Again, this mode was tested on all three alignments. This is a very new technology, with many fewer choices of examples; four types of equipment were chosen for testing.

The Siemens Regio Sprinter VT4N easily out-performed the other three candidates. This was primarily due to the fact that this train set was 18 tons lighter than its nearest competitor. This lighter weight allowed this trainset to have significantly higher acceleration and de-acceleration features. It performed better than a heavier train that had more horsepower and a higher maximum speed primarily because of its lighter weight.

Elapsed time over the Highway Alignment was twelve (12) minutes faster than any other train set tested. Final Statistics: 46.1MPH equated to 1:52" elapsed time.

<u>Diesel Heavy Rail Transit</u> - We were able to identify five sets of equipment for testing over the 4% alignment. Due to the low horsepower output of this type of equipment, performance statistics were not favorable as an alternative type of rail mode. Only two of the five train sets tested successfully completed a TPC run. The others either stalled on the 4% grades or had insufficient brakes for the long descents. Among the equipment that failed was The Colorado Transportation Associates turbine train, using the best available tractive effort and braking curves available.

The ABB Explorer/Endeavour DMU-3 was the better of the two sets that successfully completed the TPC run over the 4% alignment. Average speed over the run was 36.4MPH which equaled to a 2:30" elapsed time. 471 gallons of fuel was consumed.

<u>Electric Heavy Rail Transit</u> – These were defined as non-FRA compliant Multiple Unit trains. Thus five train sets were selected from either the North American transit or the worldwide multiple unit elements of the Railsim library. Apparently, because of the weight of this equipment, of the five sets tested, only one completed the TPC run, and only on the 4% alignment. Three of the sets stalled on the grades and one set had insufficient brakes to hold the train safely on the long descents. The performance of the one set that successfully completed the run was not competitive enough to be considered an alternative. The DB AG German 1999 Class 426 EMU averaged 34.4MPH which equated to a 2:38" elapsed time. Some trains with tilting capabilities were among those tested, but did not complete the runs. These were tested with 6 inches of cant deficiency.

We configured a user-defined high performance Electric Heavy Rail train which averaged 47.1MPH which resulted in a 1:56" elapsed time on the 4% alignment. KWH used were 6249 per run. On the 6% alignment it averaged 44.5MPH which resulted in a 1:56" elapsed time with a 6842 KWH consumption rate.

<u>Electric Multiple Unit Passenger Railroad</u> – This grouping of EMU's that was tested is North American equipment that is Federal Railway Administration (FRA) compliant. We chose four different types based on horsepower and weight.

The Montreal AMT MR90 was the only set of equipment of the four tested that successfully operated over the 4% alignment. The other three either had insufficient braking or stalled on the grades. The Montreal AMT MR90 averaged 45.7MPH which equated to a 1:59" elapsed time. KWH used was high at 6899. This was an eight car train with each car powered. This train set also completed the 6% alignment run with performance statistics of an average speed of 42.8MPH, a 2:01" elapsed time and used 6192 KWH.

<u>Passenger Railroad Locomotive-hauled trains</u> – The TPC allows the user to create various train consists. This category was defined to include only FRA compatible equipment. We tested various combinations of the most powerful passenger diesel and electric locomotives with bi-level coaches to keep weight per seat at a minimum and to satisfy passenger capacity requirements. The number of locomotives used was three to four per five or six car consist

over the 4% alignment. The various trains tested either stalled or had insufficient brakes to successfully complete the TPC run. Some runs were also made with tilting trains, using 6 inches of cant deficiency; these also were unsuccessful. It became clear that locomotive-hauled equipment, with a small fraction of the train's axles powered (and equipped with dynamic brakes), is not a viable alternative in this corridor.

<u>Advanced Guideway Systems</u> – The TPC was also used to simulate monorail operation. A conventional monorail was constructed in Railsim 7® based on the System 21 monorail being developed by Futrex Inc. of Charleston SC. This is based on a side-hanging system using small (28 feet long, 11,500 pounds) cars. Published data indicates a top speed of 70 mph, 10% max grades, 10 car maximum train length and 90 second minimum headway. Testing was performed using 26 seats, 6 inches of cant deficiency and 200 hp/car. Results were average speeds, with stops, of 56 to 58.4MPH, depending on the alignment (including stops (59.9 to 60.6 without stops) and elapsed time of 1:31-1:33, with stops. Energy consumed varied from 1855 to 1925 kWh, depending on the alignment (with stops).

The CIFGA monorail was tested using data provided by CIFGA. An experimental train was configured using this information. At CIFGA's request, only the Highway Alignment was tested. A special alignment with the equivalent of 12 inches of conventional railroad superelevation was tested with 6 inches of cant deficiency (although these might result in considerable discomfort for passengers). Results were an average speed of 65.8MPH, an elapsed time of 1:19", and 3244 KWH of energy utilized.

<u>Buses</u> – User defined vehicles were also built to simulate buses, primarily to estimate electricity consumption, to allowing sizing an electric power distribution system for trolleybuses and dual mode buses. These were built based on the specifications of a 45-foot MCI 4500 series over the road coach equipped with a 500 hp electric traction motor. Railsim's Rubber-tired vehicle resistance coefficient was used for the bus runs. Electric buses consumed 476 KWH per trip.

FGT and RTT electrification costs are shown in Appendix C. Feeder bus operations requirements are detailed in Appendix D.

Conclusions

All equipment that was tested, with the possible exception of Electric LRT, will need minor modifications to the propulsion and braking systems. Use of the TPC demonstrated conclusively that only rail equipment with, at least, 2/3 of its axles powered (and equipped with dynamic brakes) had the high-performance capabilities needed to overcome the steep gradients of the Rocky Mountain topography. Typically, such high performance equipment is used in short-distance, commuter service and is designed to serve work trips. On-board enhancements that will be required to serve longer, leisure-oriented trips include more comfortable seating, food service, and larger luggage (ski equipment) compartments. These on-board amenities will be applied to any type of equipment chosen for this service. Wide car doors are needed to keep station dwell times to a minimum. High Level platforms, avoiding the need for stairs, will also improve the ability for this equipment to maintain exacting schedules. Magnetic track brakes will also be required for emergency backup

operation on the steep mountain grades. These are also typically associated with high performance transit equipment. Tilting capability may appropriate given the extensive curvature of the alignment. While most tilt trains are locomotive-powered, a large order of high-speed EMU tilt trains is now being built for operation on the West Coast Mainline in England.

Design changes to passenger rail cars often affect the transfer of weight and balance that is critical to performance. Any rail equipment chosen for modification with on-board enhancements to operate within the I-70 corridor must keep the weight of the final design as light as possible. This fact alone is the most critical for this system to be competitive and efficient with the existing transportation modes now being utilized. Operating and Maintenance costs will directly affect the success of this system in that revenues from the farebox will be the primary source for the continuity and success of this service.

A successful passenger rail service can operate within the extreme mountain topography such as this with the associated winter conditions, as long as appropriate maintenance programs for the rolling stock and rail infrastructure is provided. In order for this alternative to be a viable transportation mode it must be safe, dependable, and efficient. A proactive approach to maintenance must be understood and adopted by the operator.

A spreadsheet is provided as Appendix B, which lists each equipment type tested. The top group shows the equipment selected from the Railsim 7® library and its key characteristics. The bottom group provided information regarding the train consist that was tested and the results of the run on each alignment.

Analysis Results

The results of the FGT analysis are documented in Table 3.

The results of the RTT analysis are documented in Table 4.



Table 1

Evaluation Matrix – FGT Alternatives

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2					6%	2	0.006/seat mile
					4%	2	0.006/seat mile

	Alternative	Area	Criteria	Alignment	Kating	Value/discussion
s	Diesel Heavy Rail Transit,	Need	System capacity		e	4320 passengers per hour in peak direction
	single track		System Attractiveness	%9	2	Food service, less smooth ride (from greater curvature) and high interior noise (due to diesel/turbine power).
				4%	2	Food service, smooth ride (from low curvature) and high interior noise (due to diesel/turbine power).
			Average Speed	6%	5	33.3mph
				4%	4	36.4mph
			Connectivity		2	Can run through from Eagle to DIA without requiring passengers to change vehicles, using Intermountain Connection, Gold Line (as identified in MIS) and DIA line.
			Feeder/Distribution Reg'ts.		3	Feeder systems in existence. Moderate change in local transit services required in the corridor
		Safety	System Safety		2	Stronger carbody construction; new alignments would be constructed with no oracle crossinos
		Implementation (Capital Cost	6%	5	\$41.1M/mile
				4%	5	\$49.0M/mile
			Technology Available	8%	e	Significant modifications would be required to handle 6% grades
				4%	-	No adaptation required.
			Fuel Availability		-	Vehicles are fossil fuelpowered.
			Fuel Limitations		2	Vehicles are fossil fuelpowered.
			Energy consumption	6%	2	0.010/seat mile
				4%	2	0.009/seat mile
4	Discol Users Bed Terrorit		Contrast and all is			
•	Diesel Licary Mail Hallshi	naan	oystern capacity		-	004U passengers per nour in peak direction
	double track		System Attractiveness	6%	2	Food service, less smooth ride (from greater curvature) and high interior noise (due to diseel/furthine power).
				4%	2	Food service, smooth ride (from low curvature) and high interior noise (due to diese/fturbine power).
			Average Speed	6%	5	33.3mph
				4%	4	36.4mph
			Connectivity		5	Can run through from Eagle to DIA without requiring passengers to change vehicles, using Intermountain Connection, Gold Line (as identified in LPA) and DIA line.
			Feeder/Distribution Reg'ts.		e	Feeder systems in existence. Moderate change in local transit services required in the corridor
			System Safety		2	Stronger carbody construction: new alignments would be constructed with no neade conscione
		Implementation (Capital Cost	6%	2	\$44.8M/mile
			1957	4%	2	\$61.1M/mile
			Technology Available	6%	e	Significant modifications would be required to handle 6% grades
				4%	-	No adaptation required.
			Fuel Availability		-	Vehicles are fossil fuelpowered.
			Fuel Limitations		2	Vehicles are fossil fuelpowered.
			Energy consumption	6%	5	0.010/seat mile
				4%	ŝ	0 009/seat mile

Need System capacity 3 Notend System capacity 6% 1 Notende Speed 6% 1 Average Speed 6% 1 Average Speed 6% 1 Average Speed 6% 1 Average Speed 6% 3 Connectivity 2% 2 Implementation Capital Cost 6% 4 Fuel Availability 6% 4 1 Fuel Limitations 6% 4 1 Need System capacity 6% 4 1 Average Speed 6% 4 1 1 Average Speed 6% 4 1 1 Average Speed 6% 4% 2 1 Average Speed		Alternative	Area	Criteria	Alignment	Rating	Value/discussion
Transit, single track System Attractiveness 6% 1 Implementation Average Speed 6% 1 Implementation Average Speed 6% 3 Implementation Erectorityty 8% 3 Implementation Erectorityty 8% 3 Implementation Erectorityty 8% 4 Implementation Erectorityty 8% 4 Implementation Erectority Available 6% 4 Implementation Erectority Availability 1 1 Implementation Erectority consumption 6% 4 1 Implementati	1	Electric Heavy Rail	Need	100,000,000		3	4200 passengers per hour in peak direction
Image Speed 4% 4% 3 Image Speed 6% 3 Connectivity 6% 3 Image Speed 6% 3 Safety System Safety 6% 3 Image Speed 6% 3 Electric Leavy Rail Technology Available 6% 4 Image Safety System Safety 6% 4 4 Image Safety System Safety 5% 4 4 Image Safety System Safety 6% 4 4 Imast, double track System Capacity 6% 4 Imast, double track System Safety 6% 4 Imast, double track System Safety 6% 4 Imast, double track 6% 4% 1 Imast, double track 8% 6% 4 Imast, double track 8% 6% 4 Imast, double track 6% 4% 1 Imast, double track 6% 4%		Transit, single track		System Attractiveness	6%	-	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric
					4%	+	powery. Food service smooth ride (from low curvature) and low interior noise (due to alcothic name)
Implementation 4% 2 Feeder/Distribution Req1s. 5% 2 Safety System Safety 6% 4 Implementation Epoter/Distribution Req1s. 3 3 Implementation System Safety 6% 4 2 Implementation Epoter/Distribution Req1s. 5% 4 2 Implementation Epoter/Distribution Req1s. 5% 4 2 Implementation Epoter/Distribution 6% 4 1 Electric Heavy Rail Need System Capacity 4% 3 1 Electric Heavy Rail Need System Capacity 6% 4 1 Itansit, double track Meed System Capacity 6% 4 1 Itansit, double track System Attractiveness 6% 4 1 1 Itansit, double track System Attractiveness 6% 4 1 1 Itansit, double track Energy consumption 6% 4% 2 1<				Average Speed	6%	3	47.2mph
$ \left \begin{array}{c c c c c c c c c c c c c c c c c c c $				-	4%	2	50.2mph
Implementation FeederDistribution Req ts. 3 Implementation Safety System Safety 6% 4 Implementation Capital Cost 6% 4 Implementation Fuel Limitations 6% 1 Fuel Limitations 6% 1 1 Fuel Limitations 6% 4% 3 Fuel Limitation 6% 4% 3<				Connectivity		ę	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection
				Feeder/Distribution Reg'ts.		3	Feeder systems in existence. Moderate change in local transit services required in the corridor
			Safety	10000		2	Stronger carbody construction; new alignments would be constructed with no grade crossinge
			Implementation	Capital Cost	6%	4	\$31.7M/mile
Image: sector of the				100	4%	2	\$40.6M/mile
				Technology Available	6%	2	Some modifications would be required to routinely handle 6% grades
Fuel Availability 5 Fuel Limitations Fuel Limitations 5% Fuel Limitations 6% 1 Flectric Heavy Rail Need System capacity 6% 1 Flectric Heavy Rail Need System capacity 6% 1 Transit, double track Average Speed 6% 1 Average Speed 6% 1 1 Proceed System Safety 6% 3 Proceed 6% 1 3 Proceed 6% 3 3 Proceed 6% 3 3 Proceed 6% 3 3 Proceed 6% 4% 3 Procon					4%	-	No adaptation required.
Fuel Limitations Fuel Limitations 1 Electric Heavy Rail Energy consumption 6% 4 Transit, double track Need System Attractiveness 6% 4 Transit, double track Average Speed 6% 3 1 Average Speed 6% 3 3 3 Electric Heavy Rail Average Speed 6% 3 3 Process Eeder/Distribution Reqts. 4% 3 3 Process Eeder/Distribution Reqts. 2 3 3 Process Freeder/Distribution Reqts. 4% 3 3 Process Freeder/Distribution Reqts. 4% 3 3 4 3 3 4				Fuel Availability		S	Vehicles are electrically-powered.
Image: Construction Energy construction 6% 4 Electric Heavy Rail Need System capacity 6% 1 Transit, double track System Attractiveness 6% 1 Average Speed 6% 1 Average Speed 6% 3 Connectivity 4% 3 Preder/Distribution Reqts. 4% 3 Preder/Distribution Reqts. 4% 3 Preder/Distribution Reqts. 6% 4 Preder/Distribution Reqts. 6% 4 Preder/Distribution Reqts. 6% 4 Preder/Distribution Reqts. 6% 3 Preder/Distribution 6% 3 Preder/Distribution 6% 3 Preder/Di	_			Fuel Limitations		-	Vehicles are electrically-powered.
Image: Control in the intervent of				Energy consumption	6%	4	0.0080
Electric Heavy Rail Need System capacity 6% 1 Transit, double track System Attractiveness 6% 1 Arenage Speed 6% 3 Peeder/Distribution Req'ts. 4% 2 Implementation Connectivity 8% 4 Feeder/Distribution Req'ts. 6% 3 Peeder/Distribution Req'ts. 4% 5 Feeder/Distribution Req'ts. 6% 4 Peeder/Distribution Req'ts. 6% 5 Feeder/Distribution Req'ts. 6% 5 Peeder/Distribution Req'ts. 6% 5 Feeder/Distribution Req'ts. 6% 5 Feeder/Distribution Req'ts. 6% 5 Peeder/Distribution Req'ts. 6% 5 Feeder/Distribution Req'ts. 6% 5 Peeder/Distribution Req'ts. 6% 5 Peeder/Distribution Req'ts. 7 6% 5 Peeder/Distribution Req'ts. 6% 3 6% Peeder/Distribution Req'ts. 7 7 7				The Strength	4%	e	0.0070
Letectric relary Kall Need System Capacity 1 Transit, double track System Attractiveness 6% 1 Particle Average Speed 6% 3 Connectivity 6% 3 Feeder/Distribution Req'ts. 3 Province 6% 4 Province 1 4% Province 6% 4 Province 6% 2 Province 6% 3		:					
System Attractiveness 6% 1 Average Speed 4% 1 Average Speed 6% 3 Connectivity 4% 2 Peeder/Distribution Reqts. 8% 3 Feeder/Distribution Reqts. 8% 2 Implementation Control 8% 2 Implementation 6% 4 4 Feeder/Distribution Reqts. 8% 2 2 Feeder/Distribution Reqts. 6% 4 2 Function Reqts. 6% 4 4 5 Function Capital Cost 6% 4 4 5 7 Function State 6% 7 4 5 7 5 7 Function Sumption 6% 3 5 7 5 7 5 7 5 7	×	Electric Heavy Rail	Need			-	9240 passengers per hour in peak direction
Average Speed 4% 1 Average Speed 6% 3 Connectivity 4% 2 Connectivity 6% 3 System Safety 6% 4 Capital Cost 6% 4 Feeder/Distribution Reqts. 6% 4 Fuel Lost 6% 2 Technology Available 6% 5 Fuel Limitations 6% 3 Fuel Sommotion 6% 3		Transit, double track		System Attractiveness	6%	-	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric power).
Average Speed 6% 3 Connectivity 4% 2 Connectivity 3 3 Feeder/Distribution Req'ts. 3 3 System Safety 6% 4 Capital Cost 6% 2 Technology Available 6% 2 Fuel Availabile 6% 3 Fuel Limitations 6% 3 Fuel Limitations 6% 3 Fuel Sonsumption 6% 3					4%	-	Food service, smooth ride (from low curvature) and low interior noise (due to electric nower)
4% 2 Connectivity 4% 2 Feeder/Distribution Reqts. 3 System Safety 6% 4 Capital Cost 6% 4 Fechnology Available 6% 2 Fuel Anailability 6% 2 Fuel Limitations 6% 3 Fuel Solution 6% 3				Average Speed	6%	5	47.2mph
Connectivity 3 Feeder/Distribution Req'ts. 3 System Safety 6% 4 Capital Cost 6% 4 Technology Available 6% 2 Fuel Availability 6% 3 Fuel Limitations 6% 3 Fuel Limitations 6% 3					4%	2	50.2mph
Feeder/Distribution Req'ts. 3 System Safety 6% 2 Capital Cost 6% 5 Technology Available 6% 2 Fuel Availability 6% 3 Fuel Limitations 6% 3 Fuel Some Numbtion 6% 3				Connectivity		en	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection required west of Vail unless it is electrified
System Safety 2 Capital Cost 6% 4 Capital Cost 6% 5 Technology Available 6% 2 Fuel Availability 4% 1 Fuel Limitations 6% 3 Energy consumption 6% 2				Feeder/Distribution Reg'ts.		e	Feeder systems in existence. Monterate channe in Incel transit continue in the consider
Capital Cost 6% 4 Technology Available 6% 5 Technology Available 6% 2 Fuel Availability 4% 1 Fuel Limitations 6% 3 Energy consumption 6% 2			Safety			2	Stronder carbudy construction: new alignments work remains an environment of the construction of the const
liable 6% 5 6% 2 4% 1 7 6% 3 bion 6% 2			Implementation		6%	4	537.2M/mile
liable 6% 2 4% 1 5 100 6% 3 4% 2					4%	2	\$54.7M/mile
4% 1 5 5 0tion 6% 3 4% 2				Technology Available	6%	2	Some modifications would be required to routinely handle 6% grades
5 5 1 0tion 6% 3 1					4%	-	Vo adaptation required.
0tion 6% 3				Fuel Availability		5	Vehicles are electrically-powered.
6% 3 4% 2				Fuel Limitations		-	Vehicles are electrically-powered.
4% 2				Energy consumption	6%	3	0.007/seat mile
					4%	2	0.006/seat mile

9 Diese Passe	Diesel Loco. hauled Passenger RR, single track	Need			•	
Passi	enger RR, single			-		Not applicable
			System Attractiveness	6%	÷	Food service, less smooth ride (from greater curvature) and low interior noise (due to locomotive
				4%	+	Food service smooth ride (from low curvature) and low interior noise (due to locomotive nower)
			Average Speed	6%		Not applicable
				4%	•	Not applicable
			Connectivity		5	Can run through from Eagle to DIA without requiring passengers to change vehicles, using Intermountain Connection, Gold Line (as identified in MIS) and DIA line.
			Feeder/Distribution Reg'ts.			
		Safety	System Safety		-	Strongest carbody construction (FRA compliant); new alignments would be constructed with no
						grade crossings.
		implementation	Capital Cost	6%	•	Not applicable
				4%		Not applicable
			Technology Available	6%	5	Locomotive-hauled trains lack adhesion for efficient operation on 6% grades
				4%	e	Significant modification would be required to routinely handle 4% grades
			Fuel Availability		-	Vehicles are fossil fuelpowered.
			Fuel Limitations		ŝ	Vehicles are fossil fuelpowered.
			Energy consumption	6%	•	Not applicable
				4%	•	Not applicable
10 Diese	Diesel I oco hauled	Naari				Met controchio Met controchio
Т						INOI applicable
Passe track	Passenger RR, double track		System Attractiveness	6%	-	Food service, less smooth ride (from greater curvature) and low interior noise (due to locomotive power).
				4%	-	Food service, smooth ride (from low curvature) and low interior noise (due to locomotive power).
			Average Speed	6%	•	Not applicable
				4%		Not applicable
			Connectivity		5	Can run through from Eagle to DIA without requiring passengers to change vehicles, using Information Connection Codd Line / se intervision in MICV and DIA inc.
			Feeder/Distribution Reg'ts.		•	
		Safety	System Safety		-	Strongest carbody construction (FRA compliant); new alignments would be constructed with no made crossions
		Implementation	Capital Cost	6%		Not applicable
				4%	•	Not applicable
			Technology Available	6%	2	Locomotive-hauled trains lack adhesion for efficient operation on 6% grades
				4%	e	Significant modification would be required to routinely handle 4% orades
			Fuel Availability		-	Vehicles are fossil fuelpowered.
			Fuel Limitations		5	Vehicles are fossil fuelpowered.
			Energy consumption	6%	•	Not applicable
				4%	•	Not applicable

11 Electric Loco. hauled Need System capacity 6% 1 Food service, less service, less service, less service, service 1 Passenger RR, single Average Speed 6% 1 Food service, less service, service 1 Passenger RR, single Average Speed 6% 1 Food service, less service, service 1 Passenger RR, single Average Speed 6% 1 Food service, service 1 Passenger RR, single Average Speed 6% 1 Food service, service 1 Passenger RR, single Passenger RR, single Passenger RR, single Passenger RR, single 1 Electronoly for applicable Electronoly for applicable Passenger RR, double Passenger RR, double Passenger RR, double 1 Electric Loco. hauled Electric Loco. hauled Passenger RR, double Passenger RR, double Passenger RP, double Passenger RR, double Passenger RP, double Passenger RP, double Passenger RR, double Passenger RP, double Passenger RP, double Passenger RP, double Passenger RP, double Passender RP, double Passenger RP, doub	Not applicable Food service, less smooth ride (from greater curvature) and low interior noise (due to electric power). Food service, smooth ride (from low curvature) and low interior noise (due to electric power). Food service, smooth ride (from low curvature) and low interior noise (due to electric power). Not applicable Not applicable Sidentified in MIS) and DIA throut requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (eastient west of Vail, unless it is electrified). Connection to Intermountain Connection (equired west of Vail, unless it is electrified). Connection to Intermountain Connection (equired west of Vail, unless it is electrified). Strongest carbody construction (FRA compliant); new alignments would be constructed with no required to construction to retriced with no synthese conssings. Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Significant modification would be required to routinely handle 4% grades Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable
Passenger RR, single System Attractiveness 6% 1 Itack Average Speed $\frac{6\%}{6\%}$ 1 Itack Average Speed $\frac{6\%}{6\%}$ 1 Itack Average Speed $\frac{6\%}{6\%}$ 1 Itack Connectivity $\frac{4\%}{4\%}$ 1 Itack Eeder/Distribution Req'ts. 1 1 Itack Implementation Capital Cost $\frac{6\%}{6\%}$ 1 Implementation Capital Cost $\frac{6\%}{6\%}$ 1 1 Implementation Exploitoly Available $\frac{6\%}{6\%}$ 1 1 Implementation Exploiton $\frac{6\%}{6\%}$ 1	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric power). Power). Not applicable Not applicable Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (FRA compliant), new alignments would be constructed with no grade crossings. Strongest carbody construction (FRA compliant), new alignments would be constructed with no grade crossings. Not applicable Not applicable
Indext 4% 1 Indext Average Speed 6% • Prevention Connectivity 5% • Prevention Safety System Safety • • Prevention Connectivity 5% • • Prevention Connectivity 5% • • Prevention Capital Cost 6% • • • Prevention Capital Cost 6% • • • • Prevention Capital Cost 6% 4% • </td <td>Power). Power I. Not applicable Not applicable Not applicable Can run through from Vall to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection tequired west of Vall, unless it is electrified. Strongest carbody construction (FRA compliant), new alignments would be constructed with no strongest carbody construction (FRA compliant), new alignments would be constructed with no Not applicable Not applicable</td>	Power). Power I. Not applicable Not applicable Not applicable Can run through from Vall to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection tequired west of Vall, unless it is electrified. Strongest carbody construction (FRA compliant), new alignments would be constructed with no strongest carbody construction (FRA compliant), new alignments would be constructed with no Not applicable Not applicable
Image Speed 6% **** Image Speed 6% **** Connectivity Connectivity 3 Feeder/Distribution Reqts. ***** ***** Image Speed 6% ****** Image Speed 6% ******* Image Speed 6% ************************************	Not applicable Not applicable Not applicable Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection (as identified in MIS) and DIA line (should be electrified). Connection to find the construction (FRA compliant), new alignments would be constructed with no grade crossings. Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable Not applicable
Image of the sector of the	Not approximate Not approximate Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection required west of Vail, unless it is electrified. Connection to Intermountain Connection grade crossings. Not applicable Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable Not applicable Not applicable Not applicable
Image: Connectivity Connectivity 3 Implementation Safety System Safety 9 Implementation Capital Cost 6% 1 Implementation Capital Cost 6% 5 Implementation Capital Cost 6% 5 Implementation Fuel Available 6% 5 Implementation Fuel Available 6% 5 Implementation Fuel Available 6% 1 Implementation Fuel Availability 5 1 Implementation Fuel Availability 6% 1 Implementation System Capacity 6% 1	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection required west of Vail, unless it is electrified. Connection to Intermountain Connection strongest carbody construction (FRA compliant), new alignments would be constructed with no grade crossings. Not applicable Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable Not applicable Not applicable Not applicable
Implementation Feeder/Distribution Requis. · </td <td> Strongest carbody construction (FRA compliant); new alignments would be constructed with no grade crossings. Strongest carbody construction (FRA compliant); new alignments would be constructed with no grade crossings. Not applicable </td>	 Strongest carbody construction (FRA compliant); new alignments would be constructed with no grade crossings. Strongest carbody construction (FRA compliant); new alignments would be constructed with no grade crossings. Not applicable
Implementation Safety System Safety 1 Implementation Implementation Capital Cost 6% • Implementation Exchnology Available 6% 5 • Implementation Exchnology Available 6% 1 • Implementation Excent consumption 6% 1 • Implementation Excent consumption 6% 1 • Implementation Excent consumption 6% 1 • • Implementation Excent consumption 6% 1 • <td>Strongest carbody construction (FRA compliant), new alignments would be constructed with no grade crossings. Not applicable Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable</td>	Strongest carbody construction (FRA compliant), new alignments would be constructed with no grade crossings. Not applicable Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable
	Not applicable Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable Not applicable
	Not applicable Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Not applicable Not applicable
	Locomotive-hauled trains lack adhesion for efficient operation on 6% grades Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Not applicable Not applicable
	Significant modification would be required to routinely handle 4% grades Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable Met contracts
Image: Construction Fuel Availability 5 Fuel Limitations Fuel Limitations 5 Fuel Limitations 6% 1 Electric Loco. hauled Need System capacity 6% 1 Passenger RR, double Need System capacity 6% 1 Passenger RR, double Need System capacity 6% 1 Image: Construction Region Average Speed 6% 1 1 Image: Connectivity Electric Loco. Average Speed 6% 1 1 Image: Connectivity Electric Loco. Average Speed 6% 1 1 Image: Connectivity Electric Loco. Average Speed 6% 1 1 Image: Connectivity Electric Loco. Average Speed 6% 1 1 Image: Connectivity Electric Loco. Average Speed 6% 1 1	Vehicles are electrically-powered. Vehicles are electrically-powered. Not applicable Met and income
Image: constraint of the sector of	Vehicles are electrically-powered. Not applicable Met applicable
Image: second	Not applicable Not applicable Met sourcestea
Image: state	Not applicable
Electric Loco. hauled Need System capacity * Passenger RR, double System Attractiveness 6% 1 track Average Speed 6% 1 Electric Loco. hauled Average Speed 6% 1 Safety System Safety 1 1	Met excitated a
Electric Loco. hauled Passenger RR, double Need System capacity * Passenger RR, double System Attractiveness 6% 1 Arrack Average Speed 6% * Average Speed 6% * * * Average Speed 5% * * * * Average Speed 5% *<	Not analizabla
enger RR, double System Attractiveness 6% 1 Average Speed 6% 1 Average Speed 6% 7 Average System Attractive 7 Safety System Safety 7	INVI applicable
Average Speed 4% 1 Average Speed 6% 1 Average Speed 6% 1 Connectivity 3 Feeder/Distribution Reqts. 1 Safety System Safety 1	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric
Average Speed 4% 1 Average Speed 6% • Connectivity 4% • Feeder/Distribution Req'ts. •	power).
Average Speed 6% • Average Speed 4% • Connectivity 3 Feeder/Distribution Req1s. • System Safety 1	Food service, smooth ride (from low curvature) and low interior noise (due to electric nower)
4% • Connectivity 3 Feeder/Distribution Reqts. • System Safety 1	Not applicable
Connectivity 3 Feeder/Distribution Reqts. •	Not applicable
Feeder/Distribution Req'ts.	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection remined wast of Vail unless it is clarified.
System Safety 1	
Ridde clossility.	Strongest carbody construction (FRA compliant); new alignments would be constructed with no grade crossings.
*	Not applicable
4%	Not applicable
Technology Available 6% 5 Locomotive-hauled t	Locomotive-hauled trains lack adhesion for efficient operation on 6% grades
4% 3	Significant modification would be required to routinely handle 4% grades
5	Vehicles are electrically-powered.
	Vehicles are electrically-powered.
Energy consumption 6% * Not applicable	Not applicable
	Not applicable

	Alternative	Area	Criteria	Alignment	Rating	Value/discussion
13	Electric Multiple Unit	Need	Need System capacity		3	4380 passengers per hour in peak direction
	Passenger RR, single		System Attractiveness	6%	-	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric
	track					power).
				4%	-	Food service, smooth ride (from low curvature) and low interior noise (due to electric power).
			Average Speed	6%	e	42.8mph
				4%	3	45.7mph
			Connectivity		33	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection
			Foodor/Distribution Docto		¢	required west of vali, unless it is electrified.
			Cretere Cofet:			reever systems in existence. Moderate change in local transit services required in the corridor
		Salety	Available intervention		F	Surongest carbooy construction (FKA compliant); new alignments would be constructed with no
						grade crossings.
		Implementation	Capital Cost	6%	e	\$26.7M/mile
				4%	4	\$35.4M/mile
			Technology Available	6%	2	Some modifications would be required to handle 6% grades
				4%	-	No adaptation required.
			Fuel Availability		5	Vehicles are electrically-powered.
			Fuel Limitations		-	Vehicles are electrically-powered.
			Energy consumption	6%	3	0.007/seat mile
				4%	2	0.006/seat mile
14	Electric Multinle Unit	Need	Sustam canacitu		÷	9760 monomente con house in south discussion
		_	of section conductory		-	or ou passerigers per riour in peak direction
	Passenger RR, double track		System Attractiveness	6%	-	Food service, less smooth ride (from greater curvature) and low interior noise (due to electric power).
				4%	-	Food service, smooth ride (from low curvature) and low interior noise (due to electric nower)
			Average Speed	6%	ო	42.8mph
				4%	3	45.7mph
			Connectivity		m	Can run through from Vail to DIA without requiring passengers to change vehicles, using Gold Line (as identified in MIS) and DIA line (should be electrified). Connection to Intermountain Connection mentified west of Vail indexs it is electrified.
			Feeder/Distribution Reg'ts.		3	Feeder systems in existence. Moderate channe in local transit convices required in the consider
		Safety	System Safety		÷	Strongest carbody construction (FRA compliant); new alignments would be constructed with no
						grade crossings.
		Implementation	Capital Cost	6%	4	\$32.1M/mile
				4%	5	\$49.5M/mile
			Technology Available	6%	2	Some modifications would be required to routinely handle 6% grades
				4%	1	No adaptation required.
			Fuel Availability		5	Vehicles are electrically-powered.
			Fuel Limitations			Vehicles are electrically-powered.
			Energy consumption	6%	2	0.006/seat mile
				4%	2	0.006/seat mile

12			minan	TIDIIII But	Sunav	Value/discussion
	Electric Conventional	Need	System capacity		-	7800 passengers per hour in peak direction
	Monorail AGS double		Svetam Attractivanaee	Hinhway	•	Dide environded he effected he high encode on the first here of the
				Lingimay	2	have quality would be affected by high speeds on line with heavy curvature; no food service.
	guideway			6%	2	
				4%	2	
			Average Speed	Highway	2	57.1mph
				6%	2	56.0mph
				4%	2	58.4mph
			Connectivity		5	Passengers would need to change at both ends of corridor, unless Gold Line. DIA Line and
						Intermountain Connection are built using same technology.
			Feeder/Distribution Reg'ts.		e	Feeder systems in existence. Moderate change in local transit services required in the corridor
		Safety	Safety System Safety		2	Middleweight vehicles on new alignment
		Implementation Capital Cost	Capital Cost	Highway.	5	\$43.4M/mile
				6%	5	\$43.6M/mile
				4%	2	\$44.7M/mile
			Technology Available	Highway	e	Only one system (in Japan) operates at average speeds over 35mph: significant adaptation
				6%	ŝ	required. Simulation data based Futrex System 21, now in early prototype phase. which promises
				4%	e	higher performance.
			Fuel Availability		S	Vehicles are electrically-powered.
1			Fuel Limitations		-	Vehicles are electrically-powered.
T			Energy consumption	Highway	-	0.005/seat mile
1				6%	-	0.005/seat mile
				4%	F	0.005/seat mile
16	CIFGA Monorail. double	Need	Need System canacity		-	10 000 pressones and hour is much discution.
	guideway	5	System Attractiveness		2	Ride guality would be affected by high speeds on line with heavy construction on food control
	Highway alignment only		Average Speed		+	65.8mph
			Connectivity		c,	Passengers would need to change at both ends of corridor, unless Gold Line, DIA Line and Intermountain Connection are built usino same technoloov.
1			Feeder/Distribution Reg'ts.		3	Feeder systems in existence. Moderate change in local transit services required in the corridor
		Safety	Safety System Safety		2	Middleweight vehicles on new alignment
1		Implementation Capital Cost	Capital Cost		5	\$51.8M/mile
			Technology Available		5	In concept planning phase
			Fuel Availability		5	Vehicles are electrically-powered.
			Fuel Limitations			Vehicles are electrically-powered.
			Energy consumption	Highway	2	0.028/seat mile

	Alternative	Area	Criteria	Alignment	Rating	Value/discussion
17	Added trains on existing	Need S	System capacity		2	1400 on one train per day
	Moffat Tunnel route to	S	System Attractiveness		+	Food service, smooth ride (from low curvature) and low interior noise (due to locomotive power).
	Winter Park	A	Average Speed		5	23.2mph
		0	Connectivity		5	All Mountain Corridor stops would be served by buses operating in mixed traffic.
		F	Feeder/Distribution Req'ts.		2	Very large network of of buses required
		Safety S	System Safety		-	Strongest carbody construction (FRA compliant): alignment has few grade crossings
		Implementation Co	Capital Cost		-	\$0.2M/mile
		Te	Technology Available		High	No adaptation required.
		F	Fuel Availability		-	Vehicles are fossil fuelpowered.
		F	Fuel Limitations		2	Vehicles are fossil fuelpowered.
		<u>u</u>	Energy consumption		5	0.0021/seat mile
18	Added trains on existing	Need S ₁	System capacity		2	1400 on one train per day
	Moffat Tunnel route to	(S)	System Attractiveness		-	Food service, smooth ride (from low curvature) and low interior noise (due to locomotive power)
	Glenwood Springs	A	Average Speed		ŝ	28.7mph
		ö	Connectivity		2	Most Mountain Corridor stops would be served by buses operating in mixed traffic.
		Fe	Feeder/Distribution Reg'ts.		5	Very large network of of buses required
		Safety S)	System Safety		+	Strongest carbody construction (FRA compliant): alignment has few grade crossings.
		Implementation Ca	Capital Cost		-	\$0.1M/mile
		Te	Technology Available		-	No adaptation required.
		2	Fuel Availability		-	Vehicles are fossil fuelpowered.
		2	Fuel Limitations		2	Vehicles are fossil fuelpowered.
		Ē	Energy consumption		ŝ	\$0.028/seat mile



Table 2

Evaluation Matrix – RTT Alternatives

Kubber Lired Lransit (KLL) Alternatives	7) Alternatives			
Alternative	Aros	Critoria	Dating	Value/Housestee
Rus and Improved Van in	-	Need System capacity	22	Valuerulscussion Capacity limited to existing highway capacity which is already over capacity
mixed traffic		System attractiveness		I nw average sneed and least comfortable vehicles would make this alternative unattractive
		Average Speed	4	36 mph
		Connectivity	-	Internal combustion engine allows through service to all destinations
		Feeder/Dist. Reg'ts.	-	Vehicles provide own distribution
		Safety System Safety	5	Operation with mixed traffic, not all drivers having CDL licensing and use of vans. with lightweight
				construction lead to lowest rating
	Implement	Implementation Capital Costs	-	\$1.2M/mile
		Technology Available	-	Conventional technology
		Fuel Availability	-	Internal combustion power
		Fuel Limitations	5	Internal combustion power
1	I	Energy consumption	4	\$0.008/seat mile
Diesel Bus in marked HOV lane, peak	Alternative transferred to Highway HOV options	Highway HOV options		
-				
Diesel Bus in marked HOV lane, both	Alternative transferred to Highway H	Highway HOV options		
Diesel Bus in separated HOV Lanes, peak	d Alternative transferred to Highway H	Highway HOV options		
Diesel Bus in separate		Need System capacity	5	24000 passengers per hour in peak direction
transitwav. neak		System attractiveness	4	Confined space. lack of food service and noisy operation reduce attractivenese
		Average Speed	2	51 mph
		Connectivity	-	Internal combustion engine allows through service to all destinations
		Feeder/Dist. Reg'ts.	ß	Requires moderate increase in local transit service to serve as feeder network
	S	Safety System Safety	4	Buses with drivers with CDL on transitway (limited to buses only)
	Implement	Implementation Capital Costs	-	\$6.1M/mile
		Technology Available	-	Conventional technology
	-	Fuel Availability	-	Diesel power
	1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (Fuel Limitations	0	Ulesel power
		Energy consumption	4	\$0.008/seat mile
Diesel Bus in separate		Need System capacity	1	24000 passengers per hour in peak direction
transitway, both		System attractiveness	4	Confined space, lack of food service and noisy operation reduce attractiveness
		Average Speed	2	51 mph
		Connectivity	F	Internal combustion engine allows through service to all destinations
		Feeder/Dist. Reg'ts.	ю	Requires moderate increase in local transit service to serve as feeder network
	S	Safety System Safety	4	Buses with drivers with CDL on transitway (limited to buses only)
	Implement	Implementation Capital Costs	-	\$9.1M/mile
		Technology Available	-	Conventional technology
		Fuel Availability	+	Diesel power
		Fuel Limitations	2	Diesel power
		Contraction of the second of t		

Alternative	Area Criteria	Raund	Value/discussion
7 Diesel Bus in auided	Need System capacity	}	24000 passengers per hour in peak direction
transitway noak	Svetem attractivenese	4	Confined small and of food service and and and and attendition and
unod (femicien	Averane Sneed		Commission approved races or 10000 activities and 1101sy uper autorit 1 cuuce attractiver 1655
		7	
-	Connectivity		Internal combustion engine allows through service to all destinations
	Feeder/Dist. Reg'ts.	3	Requires moderate increase in local transit service to serve as feeder network
	Safety System Safety	3	Buses with drivers with CDL on guided transitway (limited to buses only)
	Implementation Capital Costs	-	\$6.4M/mile
	Technology Available	2	Guideway technology has not been applied in snowy climates
	Fuel Availability	-	Diesel power
	Fuel Limitations	5	Diesel power
	Energy consumption	4	\$0.008/seat mile
Diesel Bus in mided	Need System canacity	+	24000 nacconnect new hour in near dimetion
fransitway both	Svstem attractiveness	4	Confined space lack of fond service and noisy oneration reduce attractiveness
	Average Speed	2	51 moh
	Connectivity	-	Internal combustion engine allows through service to all destinations
	Feeder/Dist. Reg'ts.	3	Requires moderate increase in local transit service to serve as feeder network
	Safety System Safety	e	Buses with drivers with CDL on guided transitway (limited to buses only)
	Implementation Capital Costs	-	S7.4M/mile
	Technology Available	2	Guideway technology has not been applied in snowy climates
	Fuel Availability	-	Diesel power
	Fuel Limitations	2	Diesel power
	Energy consumption	4	\$0.008/seat mile
Diecel Ruc in mided	Need System canacity	Ŧ	24000 nascennars ner hnir in neek direction
transition BDT stations	Svetem attractivionace	V	Ponting encourage of the section and active section active se
uditsitway, DN1 stauolis		+ c	continueu space, lack of toou service and noisy operation reduce attractiveness
		7	
	CONNECTIVITY .	_	Internal combustion engine allows through service to all destinations
	Feeder/Dist. Req'ts.	8	Requires moderate increase in local transit service to serve as feeder network
	Safety System Safety	e	Buses with drivers with CDL on guided transitway (limited to buses only)
	Implementation Capital Costs	-	\$7.6M/mile
	Technology Available	2	Guideway technology has not been applied in snowy climates
	Fuel Availability	-	Diesel power
	Fuel Limitations	5	Diesel power
	Energy consumption	4	\$0.008/seat mile
Dual Mode Bus in	Need System capacity	-	32000 passengers per hour in peak direction
separate transitway, peak	System attractiveness	3	Confined space and lack of food service affect attractiveness
	Average Speed	-	60 mph
	Connectivity	-	Internal combustion engine allows through service to all destinations
	Feeder/Dist. Req'ts.	9	Requires moderate increase in local transit service to serve as feeder network
	Safety System Safety	4	Buses with drivers with CDL on transitway (limited to buses only)
	Implementation Capital Costs	-	\$9.9M/mile
	Technology Available	2	Limited experience with dual mode buses, none at high speed
	Fuel Availability	e	Combination of diesel and electric power
	Fuel Limitations	e	Combination of diesel and electric power
	Energy consumption	4	\$0.008/seat mile

		Mand Cristom anoncity		
separate transitivary, both System attractiveness 3 Agerage Speed 1 Agerage Speed 1 Agerage Speed 1 Agerage Speed 2 Agerage Speed 2 Agerage Speed 3 Fuel Availability 3		Meed overein capacity		32000 passengers per hour in peak direction
Dual Mode Bus in guided Average Speed 1 Lanstlvvay, peak Erector(D)St Redts 3 Fuel Initiations 2 Erector(D)St Redts 3 Fuel Initiations 2 Erector(D)St Redts 3 Fuel Initiations 5 Erector(D)St Redts 3 Fuel Initiations 3 Erector(D)St Redts 3 Fuel Initiations	senarate transitway hoth	Svstem attractiveness	3	Confined space and lack of food service affect attractiveness
Implementation Connectivity 1 Evelocitions Safety System Safety 3 Implementation Capital Costs 2 Fuel Amalabilis 3	separate transitway, pour	Averane Sneed		Commission space and rack of rood service anect and develops
Tanker in the state of the		Connortinity		00 IIIpit Internet combination engine after the contract of the fit of the fi
Safety System Safety Safety Tendentusion Capital Costs 2 Tensitivary, peak Tendentusion 2 Tensitivary, peak Need System capacity 3 Fuel Limitability 3 1 Tensitivary, peak Need System capacity 3 Fuel Limitability 3 1 3 Fuel Limitability 3 1 1 American Consumption 5 1 1 State System capacity 3 1 Tensitivary, peak System catacity 3 1 Mode Bus in guided Need System catacity 3 Fuel Limitability Technology Available 3 Fuel Limitability 5 1 3 Fuel Limitability 1 3 1 Technology Available 3 1 3 Fuel Limitability 5 1 3 Technology Available 3 1 3 Fuel Limitability 5 1 3 Technology Available 3 1 1 Tensitivary, both 1 1 3 Tensitivary, both 1 1 3		CONNECTIVITY		Internal computation engine allows through service to all destinations
Implementation Stafety Advalable Technology Available Echnology Available 3 Fuel (Limitations) Echnology Available 3 Fuel (Limitations) System stated/venses 3 Fuel (Limitations) Available 3 Fuel (Limitations) 3 1 Dual Mode Bus in guided Need System capacity 1 Institutions) Connectivity 3 Energy consumption 5 3 Mode Bus in guided Need System stated/venses 3 Inablementation Capital Costs 1 Incolocy Available 3 1 Inablementation Capital Costs 3 Inablementation System states/second 1 Inablementation Capital Costs 3 Inablementation System states/second 1 Inablementation System states/second 1 Inablementation System states/second 1 Inablementation System states/second 1	-	reeder/UISI. Keq1S.	3	Requires moderate increase in local transit service to serve as feeder network
Implementation Capital Costs 2 Puel Lumitations 5 2 Puel Lumitations 5 3 Fuel Lumitations 5 3 Prenety consumption 5 1 Dual Mode Bus in guided Need System capacity 3 Prenety consumption 5 3 Prenety consumption 3		Safety System Safety	4	Buses with drivers with CDL on transitway (limited to buses only)
Technology Available Technology Available 2 Dual Mode Bus in guided Energy consumption 5 transitivary, peak System capacity 1 Energy consumption 5 Dual Mode Bus in guided Need System capacity 1 Learnitives to th Connectivity 3 Fuel Limitations 3 </td <td></td> <td>Implementation Capital Costs</td> <td>2</td> <td>\$12.2M/mile</td>		Implementation Capital Costs	2	\$12.2M/mile
Fuel Limitability 3 Dual Mode Bus in guided Fuel Limitactiveness 3 Energy consumption 5 Partiel Limitactiveness 3 Lansitway, peak Need System capacity 1 Average Speed 1 Average Speed 1 Average Speed 3 Eredy Onsumption 5 Average Speed 3 Eredy Onsumption 5 Dual Mode Bus in guided Redentific Requis 3 Eredy Consumption 5 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 2 Dual Mode Bus in guided Need System capacity 1 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 2 Dual Mode Bus in guided Need System capacity 1 Eredy Consumption 5 Dual Mode Bus in guided <t< td=""><td></td><td>Technology Available</td><td>2</td><td>Limited experience with dual mode buses, none at high speed</td></t<>		Technology Available	2	Limited experience with dual mode buses, none at high speed
Fuel Lumtations 5 Dual Mode Bus in guided Need System capacity 1 Lansitway, peak Need System capacity 1 Average Steed Average Steed 1 Connectivity Connectivity 1 Connectivity Connectivity 1 Connectivity Technology Available 3 Fuel Lumitations 3 Fuel Lumitations 3 Dual Mode Bus in guided Need System capacity 1 Dual Mode Bus in guided Need System capacity 3 Fuel Lumitations 5 1 3 Predectrolist Requires 3 5 1 Dual Mode Bus in guided Need System capacity 3 Predectrolist Requires 3 7 1 Dual Mode Bus in guided Need System capacity 3 Itansitiway, both Need System capacity 3 Dual Mode Bus in guided Need System capacity 3 Dual Mode Bus in guided </td <td></td> <td>Fuel Availability</td> <td>e</td> <td>Combination of diesel and electric power</td>		Fuel Availability	e	Combination of diesel and electric power
Dual Mode Bus in guided Energy consumption 5 Dual Mode Bus in guided Need System capacity 1 Amerage Speed Amerage Speed 1 Amerage Speed Connectivity 3 Ereder/Dist Requis. 3 Implementation Connectivity 3 Ereder/Dist Requis. 3 Implementation Connectivity 3 Energy consumption 5 Dual Mode Bus in guided Need System capacity 1 Amerage Speed 1 3 Energy consumption 5 Dual Mode Bus in guided Need System capacity 1 Energy consumption 5 Dual Mode Bus in guided Need System capacity 3 Energy consumption 5 Dual Mode Bus in guided Need System capacity 3 Energy consumption 5 Energy consumption 5 Dual Mode Bus in guided Need System capacity 3 Energy consumption 5		Fuel Limitations	9	Combination of diesel and electric power
Dual Mode Bus in guided Need System capacity transitway, peak System attractivences 1 Kransitway, peak Average Speed 1 Average Speed 1 1 Safety System Safety 3 1 Implementation Capital Costs 3 Implementation Capital Costs 3 Fuel Limitations 3 1 Statety System Safety 3 1 Statety System Safety 3 1 Fuel Limitations 3 1 Dual Mode Bus in guided Need System Safety 3 Puel Limitations 5 1 Puel Limitations 5 1 Puel Mode Bus in guided Need System Capacity 1 Puel Node Bus in guided Need System Capacity 1 Puel		Energy consumption	2	\$0.009/seat mile
Dual Mode Bus in guided Need System capacity 1 Itansitivway, peak System attractivences 3 Safety Safety 5 FeederfOlst Safety 3 Fuel Availability 3 Technology Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Limitations 3 Fuel Availability 3 System capacity 1 Connectivity 3 System attractivences 3 System attractivences 3 Dual Mode Bus in guided Need Vereage System capacity 1 Connectivity 3 Fuel Limitations 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 System capacity				
transitivay, peak System attractiveness 3 Implementation System safety 1 Connectivity Connectivity 3 Exercise Safety System safety 3 Implementation Explaid Safety 3 Fuel Limitations 5 3 Fuel Limitations 5 Dual Mode Bus in guided Need System capacity 1 Reader/Dist Request 1 Connectivity 5 Fuel Limitations 5 Fuel Available 5	1	Need System capacity	-	32000 passengers per hour in peak direction
Average Speed 1 Fedenectivity Connectivity 3 Fedenectivity Fedenectivity 3 Fuel Limitation Technology Available 3 Fuel Limitations 3 5 Fuel Limitations 5 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 5 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 5 Proverse Speed 1 Avarage Speed 1 Avarade Speetin consumption 5 <td< td=""><td>transitway, peak</td><td>System attractiveness</td><td>3</td><td>Confined space and lack of food service affect attractiveness</td></td<>	transitway, peak	System attractiveness	3	Confined space and lack of food service affect attractiveness
Connectivity Connectivity FeederOlist Reqts 3 Fuel Limitation 2stety steam cate Preventation Capital Costs Fuel Limitations 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Limitations 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Limitations 3 Availability 3 Fuel Availability 3 Fuel Availability 3 Availability 3 Availability 3 Fuel Av		Average Speed	-	60 mph
Safety Implementation Feeder/Dist Feeder/Dist Feeder/Dist Feeder/Dist Fuel Limitations Feeder/Dist Safety Fuel Limitations Safety System Safety Dual Mode Bus in guided Need System capacity System capacity Average Speed 1 Dual Mode Bus in guided Need System capacity System capacity Average Speed 1 Dual Mode Bus in guided Need System capacity System capacity Average Speed 1 Dual Mode Bus in guided Need System capacity System Safety Fuel Limitations 3 Dual Mode Bus in guided Need System capacity System Safety Fuel Limitations 3 Dual Mode Bus in guided Need System capacity System safety 1 Dual Mode Bus in guided Need System capacity System safety 1 Puel Limitations Safety System safety 3 Fuel Limitations Safety System safety 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Availability 3 Fuel Limitations 3	i i	Connectivity	-	Internal combinistion entrine allows through service to all destinations
Safety System Safety System Safety Solution Implementation Capital Costs 1 Technology Available 3 Fuel Availability 3 Fuel Available 3 Fuel Availability 3 Fue		Fooder/Dist Ron'te		Requires montarate increases in local transit seminar to serve as fooder potents
Implementation Capital Costs 1 Technology Available 3 Teuel Lumitations 3 Fuel Lumitations 3 Fuel Lumitations 3 Fuel Lumitations 3 Fuel System capacity 1 System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist Req'ts 3 Implementation Capital Costs Safety System Safety Implementation 1 Connectivity 3 Fuel Availablie 3 Fuel Available 3 </td <td>Contraction of the second</td> <td>Cafety System Safety</td> <td>0 0</td> <td>Programme interest in total italism set vice to set ve as recuer fletion.</td>	Contraction of the second	Cafety System Safety	0 0	Programme interest in total italism set vice to set ve as recuer fletion.
Technology Available 3 Tuel Availability 3 Fuel Limitations 3 Fuel Limitations 3 Fuel System capacity 5 Ready System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist Reqts 3 Implementation 3 Fuel Limitations 3 Feeder/Dist Reqts 3 Technology Available 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3 Fuel Available 3 Fuel		Imnlementation Canital Costs		SR 5M/mile
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Fuel Availability 3 Fuel Limitations 3 Energy consumption 5 Read System attractiveness 3 Average Speed 1 Connectivity 1 Connectivity 3 Ereder/Dist. Req'ts 3 System Safety 3 Implementation Capital Costs 1 Implementation Capital Costs 1 Reader/Dist. Req'ts 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Reader/Dist. Req'ts 3 Reader/Dist. Req'ts 3 Fuel Limitations 3 Fuel Limitations 3 Reader/Dist. Req'ts 3 Reader/Dist. Req'ts 3 Reader/Dist. Req'ts 3 Fuel Availablie 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 Fuel Costs 1 Reader/Dist. Req'ts 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 Safety System safety		I ECHIRIOUGY AVAILADIE	°	Liftitued experience with duar mode ouses, none at mon speed; guideway technology has not been applied in snowy climate
Fuel Limitations 3 Energy consumption 5 Need System capacity 5 System attractiveness 3 System attractiveness 3 Average System Stepd 1 Connectivity 1 Connectivity 1 Eveder/Dist Reqts 3 Implementation Capital Costs 1 Evel Availability 3 Fuel Availability 3 Fuel Limitations 3 Reconclivity 1 Safety System Safety 1 Technology Available 3 Fuel Availability 3 Fuel Stem 3 Fuel Stem 3 Fuel Stem 3 Fuel Available		Fuel Availability	e	Combination of diesel and electric power
Energy consumption 5 Need System capacity 1 System attractiveness 3 System attractiveness 3 System stractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist Req'ts 3 Implementation Capital Costs 1 Technology Available 3 Fuel Availability 3 Fuel Availabile 3 Fuel System safety 1 Fuel System Safety 1 Fuel Available 3		Fuel Limitations	3	Combination of diesel and electric power
Need System capacity 1 System attractiveness 3 System attractiveness 3 System attractiveness 3 Average Speed 1 Connectivity 1 Connectivity 3 Feeder/Dist Req'ts 3 Safety System Safety 1 Technology Available 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel System Safety 1 System attractiveness 3 Record/Dist Req'ts 3 Protrage Speed 1 Protender/Dist Req'ts 3 Reder/Dist Req'ts 3 Average Speed 1 Connectivity 1 Feeder/Dist Req'ts 3 Implementation Capital Costs 3 Fuel Available 3 Fuel Available 3 1 Safety 5 3 Fuel Available 3 1 Fuel Available 3 1 <td></td> <td>Energy consumption</td> <td>5</td> <td>\$0.009/seat mile</td>		Energy consumption	5	\$0.009/seat mile
System attractiveness 3 System attractiveness 3 Average speed 1 Connectivity 1 Eeder/Dist Req'ts 3 Safety System Safety 3 Implementation Capital Costs 1 Implementation Capital Costs 1 Fuel Availability 3 1 Fuel Limitations 3 5 Statem Stem System capacity 1 Need System capacity 1 System attractiveness 3 1 Fuel Limitations 3 1 System Steed 1 1 Implementation Consumption 5 Implementation Constantions 3 Fuel Available 3 1	Dural Mode Bue in anidod	Naard Sustam conocity	-	22000 mercenare are have in analy dimetion
System auractiveness 3 System auractiveness 3 Connectivity 1 Connectivity 1 Eeeder/Dist Reqts 3 Implementation Capital Costs 1 Technology Available 3 Fuel Availability 3 Fuel Available				
Average speed 1 Connectivity 1 Eeeder/Dist Req'ts 3 Safety System Safety 3 Implementation Capital Costs 1 Technology Available 3 Fuel Availability 3 Fuel Availability 3 Fuel Limitations 3 Fuel System capacity 1 System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist Req'ts 3 Implementation Connectivity 1 Fuel Availability 3 Fuel System attractiveness 3 Fuel Availability 3 Fuel System attractiveness 3 Fuel Available 3	transitway, both	System auracuveness	n •	Contined space and lack of food service affect attractiveness
Connectivity Connectivity Safety System Safety Safety System Safety Implementation Capital Costs Technology Available 3 Fuel Limitations 3 Fuel Limitations 3 Fuel System capacity 1 Need System capacity 1 System attractiveness 3 Average Speed 1 Implementation Connectivity 3 Fuel Availability 3 Fuel System capacity 1 System Safety 1 Implementation 3 Fuel Availability 3 Fuel System Capacity 1 System Safety 1 Fuel Available 3	-	naada ahaana	-	
Safety System Safety System Safety Implementation Capital Costs 3 Technology Available 3 Fuel Availability 3 Fuel Availability 3 Fuel Available 3 Fuel Available 3 Fuel Available 3 Fuel Availability 3 Fuel Available 3 Fuel Available 3		Connectivity	-	Internal computation engine allows through service to all destinations
Safety System Safety Implementation Capital Costs 1 Technology Availability 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Fuel System capacity 1 Need System capacity 1 System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist.Req'ts. 3 Implementation Capital Costs 1 Fuel Availability 3 Fuel Availability 3		Feeder/UISt. Keq1s.	3	Requires moderate increase in local transit service to serve as feeder network
Implementation Capital Costs 1 Technology Availablic 3 Fuel Availability 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 3 Renergy consumption 5 System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist. Req'ts 3 System Steps 3 Implementation Capital Costs Fuel Available 3		Safety System Safety	3	Buses with drivers with CDL on guided transitway (limited to buses only)
Technology Available 3 Fuel Availability 3 Fuel Limitations 3 Fuel Limitations 3 Fuel Limitations 5 Renergy consumption 5 Need System capacity 1 System attractiveness 3 Average Speed 1 Connectivity 1 Feder/Dist Req'ts 3 Implementation Consts 3 Fuel Availability 3 Fuel Availability 3 Fuel Availability 3		Implementation Capital Costs	-	\$10.5M/mile
Fuel Availability 3 Fuel Limitations 3 Fuel Limitations 3 Energy consumption 5 Need System capacity 1 System attractiveness 3 Average Speed 1 Connectivity 1 Feder/Dist. Req ^{tis.} 3 System Safety 1 Implementation Capital Costs 1 Fuel Availability 3 Fuel Availability 3 Fuel Limitations 3		Technology Available	ო	Limited experience with dual mode buses, none at high speed; guideway technology has not
Fuel Availability 3 Fuel Limitations 3 Fuel Limitations 3 Energy consumption 5 Energy consumption 5 Need System attractiveness 3 Average Speed 1 Connectivity 1 Feeder/Dist. Req"s. 3 System Safety 1 Implementation Capital Costs 3 Fuel Available 3 Fuel Available 3 Fuel Limitations 3 Fuel Limitations 3				been applied in snowy climate
Fuel Limitations 3 Energy consumption 5 Renergy consumption 5 Need System capacity 1 System attractiveness 3 Average speed 1 Connectivity 1 Feeder/Dist Req'ts 3 Safety System Safety 3 Implementation Capital Costs 1 Technology Available 3 Fuel Lunitations 3		Fuel Availability	ę	Combination of diesel and electric power
Energy consumption 5 Need System capacity 1 System attractiveness 3 System attractiveness 3 Asset 1 Connectivity 1 Connectivity 1 Feeder/Dist Req'ts. 3 Safety System Safety Implementation Capital Costs 1 Technology Available 3 Fuel Limitations 3		Fuel Limitations	3	Combination of diesel and electric power
Need System capacity 1 System attractiveness 3 System attractiveness 3 Average Speed 1 Connectivity 1 Connectivity 1 Ereder/Dist. Req ⁴ s 3 Safety System Safety Implementation Capital Costs Implementation Costs Fuel Limitations 3 Fuel Limitations 3		Energy consumption	Q	\$0.009/seat mile
System attractiveness 3 Average Speed 1 Average Speed 1 Connectivity 1 Connectivity 3 Feeder/Dist. Req"s. 3 Safety System Safety 3 Implementation Capital Costs 1 Fuel Availabile 3 1 Fuel Availabile 3 5 Fuel Limitations 3 5	Dual Mode Bus in guided	Need System capacity	-	32000 passengers per hour in peak direction
Average Speed 1 Connectivity 1 Connectivity 3 Eeder/Dist. Req'ts. 3 Safety System Safety Implementation Capital Costs Implementation Technology Available Fuel Lunitations 3 Fuel Limitations 3	transitway, BRT stations	System attractiveness	m	Confined space and lack of food service affect attractiveness
teq'ts. 3 / 3 / valiable 3 /y 3 /s		Average Speed	-	64 mph
keqtis. 3 Valiable 3 by 3 hy 3 hy 3 hy 3 hy 3 hy 3 hy 3 hy 3 hy 1 hy		Connectivity	-	Internal combustion engine allows through service to all destinations
vailable 3 by 3 ls 3 ls 3 ls 3 ls 3 ls 3 ls 3 ls 3 ls		Feeder/Dist. Req'ts.	m	Requires moderate increase in local transit service to serve as feeder network
valiable 3 by 3 ns 3	1	Safety System Safety	e	Buses with drivers with CDL on quided transitway (limited to buses only)
valiable 3 by 3 is 3		Implementation Capital Costs	-	\$10.6M/mile
		Technology Available	e	Limited experience with dual mode buses, none at high speed; guideway technology has not
				been applied in snowy climate
ςς μ		Fuel Availability	3	Combination of diesel and electric power
4		Fuel Limitations	e	Combination of diesel and electric power
0		Energy consumption	5	\$0.009/seat mile

Evaluation Matrix - RTTr4 3 of 4

5/29/01

	AIIBIIIAINA	MICO	Criteria	Raung	Value/discussion
15	Electric Bus in separate	Need	Need System capacity	-	32000 passengers per hour in peak direction
ľ	transitway. both		System attractiveness	2	Lack of connectivity, confined space and lack of food service greatly reduce attractiveness
ti.			Average Speed	÷	60 mph
			Connectivity	5	Being restricted to operation on roadways with electric power supply forces transfers at both I-70
					and Vail
			Feeder/Dist. Req'ts.	3	Requires moderate increase in local transit service to serve as feeder network
		Safety	Safety System Safety	4	Buses with drivers with CDL on transitway (limited to buses only)
		Implementation Capital Costs	Capital Costs	2	\$16.5M/mile
			Technology Available	2	No experience with electric buses at high speed
			Fuel Availability	5	Electric power
			Fuel Limitations	-	Electric power
	1		Energy consumption	2	\$0.0092/seat mile
16	Electric Bus in guided	Need	Need System capacity	1	32000 passengers per hour in peak direction
1	transitway, both		System attractiveness	5	Lack of connectivity, confined space and lack of food service greatly reduce attractiveness
			Average Speed	-	60.mph
0.00			Connectivity	5	Being restricted to operation on roadways with electric power supply forces transfers at both I-70
			Feeder/Dist. Reo'ts	6	Requires moderate increase in local transit service to serve as feeder network
ľ		Coffetie	Conton Cofet:		Diversity devices with CDI an evident service of devices the formation of the control of the con
	1	Jarley Oystern Jarley	carety oystern carety	00	buses with drivers with CUL on guided transitivay (innited to buses only)
1		Implementation	Capital Custs	7	Dilling to the second
			Technology Available	e	No experience with electric buses at high speed; guideway technology has not been applied in
					snowy climate
			Fuel Availability	5 D	Electric power
			Fuel Limitations	-	Electric power
			Energy consumption	S	\$0.009/seat mile
17	Plantin Due te entitled	Mood	Custom according	•	2000 accommon acceleration
-	Electric bus in guided	Meen	Meen of Stelli rahanity	1	22000 passelideis per lioni ili peak ullecilori
1	transitway, BRT Stations		System attractiveness	• م	Lack of connectivity, confined space and lack of food service greatly reduce attractiveness
			Average opeed		04 mpn
	1		Connectivity	ى م	Being restricted to operation on roadways with electric power supply forces transfers at both I-70 and Vail
			Feeder/Dist. Req'ts.	m	Requires moderate increase in local transit service to serve as feeder network
		Safety	Safety System Safety	ę	Buses with drivers with CDL on guided transitway (limited to buses only)
		Implementation Capital Costs	Capital Costs	2	\$14.4M/mile
			Technology Available	m	No experience with electric buses at high speed, guideway technology has not been applied in
					snowy climate
1			Fuel Availability	5	Electric power
			Fuel Limitations	+	Electric power
			Energy consumption	5	\$0.009/seat mile



Table 3

FGT Analysis Results

capacity														
	Holiday		Max.											
	Peak Day Peak hour	Minumum	number of Irains per	Required Capacity										
Single-track altermatives	ridership 4200	headway 10 min	hour 6	per train 700										
Double-Irack altermatives	4200	5 min	12	350										
Added "Ski Train"	700	1 train	-	200										
									One-way running time (minutes)	way j time tes)	Round-Irip		Holiday Peak	
Alternatives	Holiday Peak headway (minutes)	Number of trains operated per hour	Capacity	Max. Number of cars per train	Capacity ner train	Number of locos required	Capacity new hour	Capacity per hour with minimum	1470 -	-	running time DIA-VAL (minutes, incl. 15%	Number of Trains	Number of Number of Internet of Trains Cars	Number o locos
Single-track alternatives			and ind					Incouncies	THA	611)	recovery)	required	required	required
1a Diesel Light Rail Transit-4% 1b Diesel Light Rail Transit-6%	9 9	6	5	4 -	236	NA	1416	1416	112	157	338	34		NA
1c Diesel Light Rail Transit-Hwy	10	0 00	88	द च	236		1416	1416	113	155	340	34		NA
3a Electric Light Rail Transit-4%	10	9	55		220		1320	1320	109	154	331	5 8	13	MA
3b Electric Light Rail Transil-6%	9	9	55		220		1320	1320	107	152	327	88		MAN
Sci clecurc Light Rait Transit-hwy 5a Diesel Heavy Rait Transit-4%	P \$	0	8		220	NA	1320	1320	107	152	327	33		NA
5b Diesel Heavy Rall Transit-6%	2 🛱	9 49	8 8	12	044		4320	4320	150	195	419	4	503	NA
7a Electric Heavy Rail Transit-4%	10	9	50		700	NA	4200	4200	116	161	346	2 50		NA
7b Electric Heavy Rail Transit-6%	10	9	50		200		4200	4200	116	161	346	35		NA
96 Diesel Loco, hauled Passenger RR-6%	stalled			447	No. 1	Sen			A STORE					
11a Electric Loco. hauled Passenger RR-6%	stalled									T				
13a Electric Multiple Unit Passenger RR-4%	10	Ð	23	10	730	NA	4380	4380	119	164	353	35	353	NA
13D Electric Multiple Unit Passenger RR-6%	8	9 ,	12	10	130	NA	4380	4380	121	166	357	36		NA
Loco, hauled Psgr RR	8		140	Ø	840	17	840	840	150	NA	NA	-	G	2
18 Moffat Tunnel - DUT to Glerwood Diesel Loco. hauled Psgr RR	8		140	9	840	2	840	840	385	NA	NA	1 12.00	9	2
							-		S	1	20.12			
Double-track altermatives 2a Diesel Linht Rail Transit-4%	v	42	G	and the second	me	-		-						
2b Diesel Light Rail Transit-6%	o uo	11	88	14	236	NA	2640	2832	112	157	338	89	270	NA
2c Diesel Light Rail Transit-Hwy	ŝ	12	65		336	NA	2640	2832	112	157	338	8 8	270	NA
4a Electric Light Rail Transit-4%	0	12	58		220	NA	2640	2640	109	154	331	88	265	M
de Flactric Light Dail Transit-078	0 4	71	81		220	NA	2640	2640	107	152	327	88	261	NA
Ga Diesel Heaw Rail Transit-4%	01	9	8 5		077	NA	2640	2640	107	152	327	88	261	NA
6h Diesel Heavy Rail Transit-6%	10		88		044	MA	OUCP	0040	DC1	500	419	42	503	NA
8a Electric Heavy Rail Transit-4%	10	9	50	14	700	M	4200	8400	116	161	346	25	286	NA
8b Electric Heavy Rail Transit-6%	9	9	20	000	1002	NA	4200	8400	116	161	346	88	485	MAN
10b Diesel Loco. hauled Passenger RR-6% 12a Electric Loco. hauled Passenger RR-6%	stalled				and the second	(1) (市))								
12b Electric Loco. hauled Passenger RR-6%	stalled			Ī				Ī						
14a Electric Multiple Unit Passenger RR-4%	9	9	£	10	062	NA	4380	8760	119	164	353	35	353	NA
15a Electric munipie Unit Passenger KK-0%	1 375	به م	EL Inc	101	130	NA	4380	8760	119	164	353	35	353	NA
15b Electric Monorali AGS-6%	3.75	16	26	0	760	MA	4150	7 900	88	138	297	62	791	NA
15c Electric Monorall AGS-Hwy	3.75	16	26	101	260	MA	4400	008'1	78	137	295	19	785	MAN
		il other				5	10017	1 March	5	136	000	10	COL	

FGT Costs-r16 Capacity 1 of 1

Sorted by Average	e Speed (including s	stops)			
DP 4%	PRR_Corridor	Single	-	-	
DP 4%	PRR_Corridor	Double	2	_	
EP 4%	PRR_Corridor	Single	-	-	
EP_4%	PRR_Corridor	Double	-	-	
DP_6%	PRR_Corridor	Single	20		
DP_6%	PRR_Corridor	Double	_		
EP_6%	PRR_Corridor	Single	T.) 20		
EP_6%	PRR_Corridor	Double	-		
EP HA	CIFGA Monorail	Double		and the second second	65.8
EP 4%	AGS_Conv Mono	Double	and the second secon	2	58.4
EP_HA	AGS_Conv Mono	Unit		2	57.1
EP_6%	AGS_Conv Mono	Unit			56
EP_4%	LRT	Single		2 2	50.2
EP_4%	LRT	Double		2	50.2
DP 4%	LRT	Single		3	
DP 4%	LRT	Double		3	48.7
EP HA	LRT			3	48.7
EP_HA	LRT	Single		3	48.6
EP_6%	LRT	Double		3	48.6
EP_6%	LRT	Single Double		3	48.4
EP_4%	HRT				48.4
EP_4% EP_4%	HRT	Single		3	47.2
DP_HA	LRT	Double			47.2
DP_HA		Single		3	46.1
DP_6%	LRT	Double		3	46.1
	LRT	Single		3	45.8
DP_6%	LRT	Double		3	45.8
EP_4%	MUP	Single		3	45.7
EP_4%	MUP	Double		3	45.7
EP_6%	HRT	Single		3	44.6
EP_6%	HRT	Double		3	44.6
EP_6%	MUP	Single		3	42.8
EP_6%	MUP	Double		3	42.8
DP_4%	HRT	Single		4	36.4
DP_4%	HRT	Double	and an a line in the second second	4	36.4
DP_6%	HRT	Single		4	33.3
DP_6%	HRT	Double		5	33.3
DP_Glenwood	PRR_Moffat			5	28.7
DP_Winter Park	PRR_Moffat	and the second second	and the second second	5	23.2

of ea ay-Hwy ay-6% track-4% track-6% rack-6%	of trains each direction 40940 40940 15755	Number of cars	Cartrine				Annual Fuel cost		
ea c Conv. Monorail, double guideway-4% c Conv. Monorail AGS, double guideway-Hwy c Conv. Monorail AGS, double guideway-6% c Multiple Unit Passenger RR, double track-4% Monorail (Highway only) c Light Rail Transit, double track-4% c Multiple Unit Passenger RR, double track-6% c Multiple Unit Passenger RR, single track-4% c Light Rail Transit, single track-4% c Light Rail Transit, double track-4% c Light Rail Transit, double track-4% c Light Rail Transit, double track-6% c Light Rail Transit, double track-6%	each direction 40940 40940 40940 15755	of cars	On trine				/@0.10 ner hwh /		
c Conv. Monorail, double guideway-4% c Conv. Monorail AGS, double guideway-4% c Conv. Monorail AGS, double guideway-6% c Multiple Unit Passenger RR, double track-4% Monorail (Highway only) c Light Rail Transit, double track-4% c Multiple Unit Passenger RR, single track-6% c Heavy Rail Transit, double track-4% c Multiple Unit Passenger RR, single track-4% c Light Rail Transit, double track-6% c Light Rail Transit, double track-6% c Light Rail Transit, double track-6%	40940 40940 40940 40940 15755		cdin ibo	Seats	Seats Round trip		(10 PCI NIII 1		Cost per seat
y-Hwy y-6% ack-4% ack-4% ack-6%	40940 40940 40940 15755		opeiateu	hel cal IIIIes		seal miles	D0.1¢	_	mile
× % % %	40940 40940 15755	10	409400	26	228	2,426,923,200	\$ 12,078,338	38 S	0.005
%	40940	10	409400	26	226	2,405,634,400	\$ 12,058,836	36 \$	0.005
	15755	10	409400	26	226	2,405,634,400	\$ 12,513,886	36 \$	0.005
		10	157550	73	228	2,622,262,200	\$ 14,758,649	49 \$	0.006
	28904.2	20	578084	20	226	2,612,939,680	\$ 14,894,897	37 \$	0.006
	31510	4	126040	55	228	1,580,541,600	\$ 9,121,891	31 \$	0.006
	15755	10	157550	73	226	2,599,259,900	\$ 15,491,703	33 \$	0.006
	15755	14	220570	50	228	2,514,498,000	\$ 15,634,311	11 \$	0.006
	15755	10	157550	73	228	2,622,262,200	\$ 16,324,067	37 \$	0.006
	15755	4	63020	55	228	790,270,800	\$ 5,044,715	15 \$	0.006
	31510	4	126040	55	226	1,566,677,200	\$ 10,022,571	71 \$	0.006
	31510	4	126040	55	226	1,566,677,200	\$ 10,147,666	36 \$	0.006
	15755	10	157550	73	226	2,599,259,900	\$ 17,134,874	74 \$	0.007
8b Electric Heavy Rail I ransit, double track-6%	15755	14	220570	50	226	2,492,441,000	\$ 17,117,931	31 \$	0.007
%	15755	14	220570	50	228	2,514,498,000	\$ 17,292,608	38 \$	0.007
	15755	4	63020	59	228	847,745,040	\$ 5,907,840	40 S	0.007
	31510	4	126040	59	228	1,695,490,080	\$ 11,815,680	30 \$	0.007
۷	15755	4	63020	55	226	783,338,600	\$ 5,542,822	22 \$	0.007
	15755	4	63020	55	226	783,338,600	\$ 5,612,003	33 \$	0.007
9	15755	14	220570	50	226	2,492,441,000	\$ 18,933,593	33 \$	0.008
	15755	4	63020	59	226	840,308,680	\$ 6,498,624	24 \$	0.008
Ŵ	31510	4	126040	59	226	1,680,617,360	\$ 12,997,248	48 \$	0.008
	15755	4	63020	59	226	840,308,680	\$ 6,547,856	56 \$	0.008
	31510	4	126040	59	226	1,680,617,360	\$ 13,095,712	12 \$	0.008
	15755	12	189060	60	228	2,586,340,800	\$ 23,188,272	72 \$	0.009
	15755	12	189060	60	228	2,586,340,800	\$ 23,188,272	72 \$	0:009
	15755	12	189060	60	226	2,563,653,600	\$ 24,960,624	24 \$	0.010
	15755	12	189060	60	226	2,563,653,600	\$ 24,960,624	24 S	0.010
17 Moffat Tunnel to Winter Pk. Diesel Loco. hauled Psgr RR	100	9	600	140	134	11,256,000	\$ 320,000	30 S	0.028
18 Moffat Tunnel to Glenwood Diesel Loco. hauled Psgr RR	100	9	600	140	268	22,512,000	\$ 640,000	\$ 00	0.028

FGT Costs-r16 Fuel 1 of 1

5/14/01

8a Electric Heavy Rail Transit, double track-4%	Normal days (265) Peak Days (75)	37 51	14 518 14 714	118,104 162,792	\$ 2.68	NA NA	NA NA	A 62	49 5,437 49 4,874	294	3 88	2 \$ 16.00 2 \$ 16.00	\$ 436,283	NA S	\$ 49,717	\$ 14,117		
	Holiday Peak Days (25) Annual	15755	14 1190 14 220570	271,320 50,289,960	\$ 2.68 \$ 2.68	NA NA	NA NA		49 3,874 49	490) 90854		1 \$ 16.00 2 \$ 16.00		NA S NA	and the second se		\$ 2,856,000	157,628,3
b Electric Heavy Rail Transit, double track-6%	Normal days (265) Peak Days (75)	37	14 518 14 714	117,068 161,364	\$ 2.68 \$ 2.68	NA	NA NA		42 5,953 42 5,337			2 \$ 16.00		NA S	\$ 44,049 \$ 54,435			
	Holiday Peak Days (25) Annual	15755	14 1190 14 220570	268,940 49,848,820	\$ 2.68	NA	NA NA	A 68	42 0,007 42 4,242 42		3 147	1 \$ 16.00 2 \$ 16.00	\$ 720,759	NA S NA S	\$ 72,115	23,528	\$ 2,856,000	157,929,7
a Diesel Loco. hauled Passenger RR,	stalled					L service of charter		ter come to you										
single track-4%				and another stars														
b Diesel Loco. hauled Passenger RR,	stalled	的自己的基本的	s an		il Chairtean	KARAN PA	(181)-14-180	Contraction (1979)		a serie that de l	atta a fa far an ar th	1993 A.F. A.F. 8	alterestere de			的复数形式	an an thaile an	的意思。但是不是错误
single track-6%	Stalled																	
		97.34 - C. F. F. F.	1997 - 1997 - 1996 -	a Maria Maria		No. In		Production of the	interneties.	art des et	1244 (MAN) - 16 (MAN)	1. N. 9. 99 - 1		如何的时候的	NEAR CORRECT			14.7-3-3-3-4-5
Da Diesel Loco. hauled Passenger RR, double track-4%	stalled											1						-
		N MARSON D	Ser Carlo Series		14135156	REALTHOR	and a start		5.0825730	a car in	NUT DE LE	STATISTICS.		STALL STAL	STATISTICS.	n tanggan		CARLON DEMIL
b Diesel Loco. hauled Passenger RR,	stalled																	
double track-6%		and a constant		and the second starts			in marker was the									and the second second		
Electric Loss, kouled Becommen BB		-58.8384 E.C. 57	relate this shall be	i di Bradi, Kiber		a an	CHARTER AND	Louis and the	and the second	to shell she look	e en la esta de la compañía de la co	and the second			an an der server	n an	同時的美国网络加	如何是王朝的子
a Electric Loco. hauled Passenger RR, single track-4%	stalled																	
		CANEL STOCK	ien de Maria	REPORT	ting yang	TO MARK	9.1-67.5 BRAR)	345 SH (256	19772678/5		NH TSERVERING	1997-866		19,295,357	NG COLLECTION			
Ib Electric Loco. hauled Passenger RR, single track-6%	stalled																	
			41 10769 201		N. ETERNA	a strange	1	98 - 12 Anilla		a an	THE DEPART	1.745 (1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.	News Week	NE CARNINALS				ANG DENIS DES
2a Electric Loco. hauled Passenger RR,	stalled															an a	and a second set of	e o de la paga de la constructione.
double track-4%								an side wars to								and the second second second		
		12-1214 Mile + 2494	ander i der Berley der Berley	rusera:	法运行的		en an				tost mala tenama		中国大学中国大学				leader in the test of the	
2b Electric Loco. hauled Passenger RR, double track-6%	stalled																	
	- State State State State		ATP STREEPER		an san an san san san san san san san sa		130601345		KING REST	an a		1995-1696	ESSING (1985)			你们这次 为	· Visiatiki da	
3a Electric Multiple Unit Passenger RR, single track-4%	Normal days (265) Peak Days (75)	37	10 370 10 510	83,620 115,260	\$ 4.72 \$ 4.72	NA NA	NA NA			218 300		\$ 16.00 \$ 16.00		NA \$		5 10,449 5 14,402		
	Holiday Peak Days (25) Annual	85	10 850 10 157550	192,100 35,606,300	\$ 4.72	NA NA	NA NA	58	4,601	500 92692	3 1500	\$ 16.00 \$ 16.00	906,712	NA S	78,221	24,004	\$ 2,856,000	191,691,01
Bb Electric Multiple Unit Passenger RR,	Normal days (265)	37	10 370		\$ 4.72	NA	NA NA			220		\$ 16.00	an ar matalan ing protocol adap	NA \$		10,567		
single track-6%	Peak Days (75) Holiday Peak Days (25)	51 85	10 510 10 850		\$ 4.72	NA NA	NA NA	61	4,830		3 1517	\$ 16.00 \$ 16.00 \$	906,712	NA \$	82,106	24,276		
	Annual Annual	15755	10 157550	35,606,300		NA	NA NA	and shares		93742		\$ 16.00		NA \$	Constant of the party of the second		\$ 2,856,000	192,552,23
a Electric Multiple Unit Passenger RR, double track-4%	Normal days (265) Peak Days (75) Holiday Peak Days (25)	37 51 85	10 370 10 510 10 850	83,620 115,260 192,100	\$ 4.72	NA NA	NA NA NA NA NA NA	58	9 4,601	218 300 500	3 900	\$ 16.00 \$ 16.00 \$ 16.00	544,027	NA \$ NA \$ NA \$	46,932			
	Annual	15755	10 157550	35,606,300		NA	NA NA			92692		\$ 16.00		NA S NA	and the standard with a standard of the state of		\$ 2,856,000	190,125,59
4b Electric Multiple Unit Passenger RR, double track-6%	Normal days (265) Peak Days (75)	37	10 370 10 510	83,620 115,260	\$ 4.72 \$ 4.72	NA	NA NA			220 303		\$ 16.00 \$ 16.00		NA \$		10,567		
	Holiday Peak Days (25) Annual	85 15755	10 850 10 157550	192,100		NA NA	NA NA	61	3,839	506 93742	3 1517	\$ 16.00 \$ 16.00	906,712	NA S NA S	65,264	24,276	\$ 2,856,000	190,909,06
5a Electric Conv. Monorall, double guideway-4%	Normal days (265)	96	10 960	216,960	\$2.00		NA NA			269		\$ 16.00		NA \$	31,036			
	Peak Days (75) Holiday Peak Days (25)	133	10 1330 10 2210	300,580 499,460	\$2.00 \$2.00	NA NA	NA NA	18	8 1,152	269 269	2 538	\$ 16.00 \$ 16.00	998,920	NA \$	50,917			
5b Electric Conv. Monorail AGS, double guideway-6%	Annual Normal days (265)	40940	10 409400	92,524,400	\$2.00	NA				269		\$ 16.00 1 \$ 16.00 1		NA \$	12,078,338 32,155	8,608	\$ 2,856,000	199,991,74
	Peak Days (75) Holiday Peak Days (25)	133	10 1330 10 2210	300,580	\$2.00 \$2.00	NA	NA NA	19	5 1,502	269	2 538	\$ 16.00 \$ 16.00	601,160	NA \$	39,940	8,608		
	Annual	40940	10 409400	92,524,400	\$2.00	NA	NA NA			269		\$ 16.00		NA \$			\$ 2,856,000	200,427,29
5c Electric Conv. Monorail AGS, double guideway-Hwy	Normal days (265) Peak Days (75)	96	10 960 10 1330	216,960 300,580	\$2.00 \$2.00	NA NA	NA NA			273 273		\$ 16.00 \$ 16.00		NA \$	30,986 3 38,488 5	8,736 8,736		
	Holiday Peak Days (25) Annual	221 40940	10 2210 10 409400	499,460 92,524,400	\$2.00 \$2.00	NA NA	NA NA			273 273		\$ 16.00 \$ 16.00		NA \$			\$ 2,856,000	199,972,37
16 CIFGA Monorail (Highway only)	Normal days (265)	68	20 1920	433,920	\$2.00	NA	NA NA			269		\$ 16.00		NA \$				
	Peak Days (75) Holiday Peak Days (25)	94	20 2660 20 3060	601,160 691,560	\$2.00 \$2.00	NA NA	NA NA	32	3 2,011	269 269	3 807	\$ 16.00 S	1,383,120	NA S	61,526			and arrive to a serie
17 Moffat Tunnel to Winter Pk.	Annual Normal days (265)	28904	20 578084	130,646,984	\$2.00	NA	NA NA	32	IS NOT CONTRACT	269	3 807	\$ 16.00	261,293,968	NA \$	14,894,897	12,912	\$ 2,856,000	279,057,77
Diesel Loco. hauled Psgr RR (from DUT)	Peak Days (255) Holiday Peak Days (25)	1	6 6 6 6			2 2	268 \$ 7 268 \$ 7			5		\$ 16.00 \$ 16.00						
	Annual	100	6 600		\$ 3.00		26800 \$ 7			500		\$ 16.00						772,80
18 Moffat Tunnel to Glenwood Diesel Loco. hauled Psgr RR	Normal days (265) Peak Days (75)	0	0 0	1.608	\$ 3.00	2	536 \$ 7	.00 20	0 2,000	10	3 30	\$ 16.00	4,824	\$ 3,752 \$	6,400 5	480		
(from DUT)	Holiday Peak Days (25)	1	6 6	1,608	\$ 3.00 \$ 3.00	2	536 \$ 7 53600 \$ 7	.00 20	2,000		3 30	\$ 16.00 \$ 16.00	4,824	\$ 3,752 \$	6,400 \$	480	and a state of the state	1,545.60

FGT Costs-r16 Operating costs 2 of 2

		Number c trains	of Number o	of		Cost per		Loco.	Cost per	Fuel (kwh or gal)	Fuel (kwh or gal) consumed per trip adjusted for	Train			ost per			Fuel cost (\$0.10 per		Other staff (station, fare inspection,	
liternatives		each direction	cars per train	Car trips operated	Car miles operated	car mile (w/o fuel)		s miles	loco mile (w/o fuel)	consumed per trip		hours per day/year C		Crew pe		Total car mile cost (w/o fuel)	Total loco mile cost (w/o fuel)	kwh or \$1.60 per gal)	Total Crew cost	dispatch,	Tot
1a Diesel Light Rail Transit, single track-4%	Per Normal day (265)	37	7 4	148	33,744	\$ 3.00	NA	NA	NA	120	120	208	5	1042 \$	16.00 \$	101,232	NA	\$ 14,208	\$ 16,675	mgmt)	
	Per Peak Day (75) Per Holiday Peak Day (25)	51		4 204 4 340	46,512 77,520			NA NA	NA	120 120		287 479	5	1437 \$ 2394 \$				\$ 19,584 \$ 32,640	\$ 22,984 \$ 38,307		
	Annual	1575		63020	14,368,560			NA	NA	120		88753	5	443766 \$			a set a set of the set of the set of the	\$ 5,907,840		\$ 2,285,000	APR TO
1b Diesel Light Rail Transit, single track-6%	Per Normal day (265)	37	7 4	148	33,448	\$ 3.00	NA	NA	NA	133	133	210	5	1048 \$	16.00 \$	100,344	NA	\$ 15,747	\$ 16,773		+
	Per Peak Day (75)	51		4 204	46,104	\$ 3.00	NA	NA	NA	133	133	289	5	1445 \$	16.00 \$	138,312	NA	\$ 21,706	\$ 23,120		
	Per Holiday Peak Day (25) Annual	15755		4 340 4 63020	76,840 14,242,520	\$ 3.00		NA NA	NA NA	133		482 89278	5	2408 \$ 446392 \$			PARTICIPATION COMPANY	\$ 36,176 \$ 6,547,856	strates to by "heads" and the achieve	\$ 2,285,000	12 354
																A. 19.10. 12.12.12.1		and the second		• =======	1 and the
1c Diesel Light Rail Transit, single track-Hwy	Per Normal day (265) Per Peak Day (75)	37		148		\$ 3.00		NA	NA	132 132		208	5	1042 \$ 1437 \$		100,344 138,312		\$ 15,629 \$ 21,542	\$ 16,675 \$ 22,984		
	Per Holiday Peak Day (25)	85		340		\$ 3.00	NA	NA	NA	132		479	5	2394 \$	16.00 \$	230,520	NA	\$ 35,904	\$ 38,307	THE SHE WAS A CONTRACT	1
	Annual	15755	4	63020	14,242,520	\$ 3.00	NA	NA	NA	132	N. H. S. Cold Star	88753	5	443766 \$	16.00 \$	42,727,560	NA	\$ 6,498,624	\$ 7,100,253	\$ 2,285,000	2000
2a Diesel Light Rail Transit, double track-4%	Per Normal day (265)	74		1 296		\$ 3.00		NA	NA	120	120	417	5	2084 \$	16.00 \$	202,464	NA	\$ 28,416	\$ 33,349		
	Per Peak Day (75)	102		408		\$ 3.00		NA	NA	120	120	575	5	2873 \$		279,072		\$ 39,168			
	Per Holiday Peak Day (25) Annual	31510	the second s	1) 680 1 126040	28,737,120	\$ 3.00	WELL CLOTTEN -	NA NA	NA NA	120 120	120	958 177506	5	4788 \$ 887532 \$	6	ATT 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	and the second states of a states	\$ 65,280 \$ 11,815,680	AT 25 25 5 42 1 5 20 1	\$ 2,285,000	an still
2h Dispol Light Boil Transle Jouble for the 201											and the second s								and the second		and the
2b Diesel Light Rail Transit, double track-6%	Per Normal day (265) Per Peak Day (75)	74		408	66,896 92,208	\$ 3.00 \$ 3.00		NA	NA NA	133 133	133 133	419 578	5	2097 \$		200,688		\$ 31,494 \$ 43,411			
	Per Holiday Peak Day (25)	170	2 4	680	153,680	\$ 3.00	NA	NA	NA	133	133	963	5	4817 \$	16.00 \$	461,040	NA	\$ 72,352	\$ 77,067	and the second second	1916.54
	Annual	31510	4	126040	28,485,040	\$ 3.00	NA	NA	NA	133	A SALE STAR	178557	5 8	392783 \$	16.00 \$	85,455,120	NA	\$ 13,095,712	\$ 14,284,533	\$ 2,285,000	
2c Diesel Light Rail Transit, double track-Hwy	Per Normal day (265)	74		296		\$ 3.00		NA	NA	132	132	417	5	2084 \$		200,688		\$ 31,258			
	Per Peak Day (75) Per Holiday Peak Day (25)	102		408	92,208 153,680			NA NA	NA NA	132 132	132 132	575 958	5	2873 \$ 4788 \$		276,624		\$ 43,085 \$ 71,808	\$ 45,968 \$ 76,613		
	Annual	31510		126040	28,485,040		Mana to a to to the	NA	NA	132	21543.2	177506	5 5	387532 \$				\$ 12,997,248		\$ 2,285,000	ball-The
3a Electric Light Rail Transit, single track-4%	Per Normal day (265)	37	7 4	148	33,448	\$ 2.68	NA	NA	NA	1823	1,695	204	5	1021 \$	16.00 \$	89,641	NA	\$ 12,546	\$ 16,329		
	Per Peak Day (75)	51		204	46,104	\$ 2.68	NA	NA	NA	1823	1,622	281	5	1407 \$	16.00 \$	123,559	NA	\$ 16,549	\$ 22,508		
	Per Holiday Peak Day (25)	15755		340 63020	76,840 14,242,520		NA NA	NA NA	NA NA	1823 1823	1,422	469 86915	5	2345 \$ 134575 \$			Construction and the second second second	\$ 24,173 \$ 5,044,715		\$ 2,856,000	NO. OR
24 Electric Light Dell Tropelt single track (0)	De Maria I des (2000)			110																	1.47 142
3b Electric Light Rail Transit, single track-6%	Per Normal day (265) Per Peak Day (75)	37	-	148	46,104	\$ 2.68 \$ 2.68	NA NA	NA NA	NA NA	2028	1,886	202	5	1008 \$ 1390 \$	16.00 \$ 16.00 \$	89,641 123,559		\$ 13,957 \$ 18,410			
	Per Holiday Peak Day (25)	85		340	76,840		NA	NA	NA	2028	1,582	463	5	2316 \$	16.00 \$	205,931	NA	\$ 26,891	\$ 37,060	The second state of the second state	
	Annual	15755	0.6.72 DOLTO 4	63020	14,242,520	\$ 2.68	NA	NA	NA	2028	all's statist	85865	5 4	129324 \$	16.00 \$	38,169,954	NA	\$ 5,612,003	\$ 6,869,180	\$ 2,856,000	at el s
3c Electric Light Rail Transit, single track-Hwy	Per Normal day (265)	37		148		\$ 2.68		NA	NA	2003	1,863	202	5	1008 \$		89,641		\$ 13,785			
	Per Peak Day (75) Per Holiday Peak Day (25)	51		204	46,104 76,840	\$ 2.68	NA NA	NA NA	NA NA	2003 2003	1,783	278 463	5	1390 \$ 2316 \$	16.00 \$ 16.00 \$	123,559 205,931		\$ 18,183 \$ 26,560			
	Annual	15755	5	63020	14,242,520		NA	NA	NA	2003	S. 7. 5 W.	85865	5 4	129324 \$			to the Aller share when	\$ 5,542,822		\$ 2,856,000	a as a T
4a Electric Light Rail Transit, double track-4%	Per Normal day (265)	74	4 4	296	66.896	\$ 2.68	NA	NA	NA	1823	1,586	408	5	2041 \$	16.00 \$	179,281	NA	\$ 23,473	\$ 32,659		
	Per Peak Day (75)	102		408		\$ 2.68		NA	NA	1823	1,422	563	5	2814 \$	16.00 \$	247,117	NA	\$ 29,008	\$ 45,016		
	Per Holiday Peak Day (25) Annual	31510		680 126040	153,680 28,485,040	\$ 2.68	NA NA	NA NA	NA NA	1823 1823	1,130	938 173830	5 5 8	4689 \$ 369151 \$			NA	\$ 38,429		C 0.050.000	Pres Time
					20,400,040	\$ 2.00		A COMPANY		1023	States and	173030	5 0	509151 \$	10.00 \$	76,339,907	NA	\$ 9,121,691	\$ 13,906,413	\$ 2,856,000	(lice)
4b Electric Light Rail Transit, double track-6%	Per Normal day (265) Per Peak Day (75)	74				\$ 2.68 \$ 2.68	NA NA	NA NA	NA NA	2028 2028	1,764 1,582	403 556	5	2017 \$ 2780 \$		179,281		\$ 26,113 \$ 22,270			
	Per Holiday Peak Day (25)	170	4	680	153,680	\$ 2.68	NA	NA	NA	2028	1,582	927	5	4633 \$		247,117 411,862		\$ 32,270 \$ 42,750			
	Annual	31510	4	126040	28,485,040	\$ 2.68	NA	NA	NA	2028	States and	171730	5 8	358648 \$			NA	\$ 10,147,666		\$ 2,856,000	
4c Electric Light Rail Transit, double track-Hwy	Per Normal day (265)	74		296		\$ 2.68	NA	NA	NA	2003	1,743	403	5	2017 \$		179,281		\$ 25,791			
	Per Peak Day (75) Per Holiday Peak Day (25)	102		408		\$ 2.68 \$ 2.68	NA NA	NA NA	NA NA	2003 2003	1,562 1,242	556 927	5	2780 \$		247,117		\$ 31,872	\$ 44,472		
	Annual	31510		126040	28,485,040		NA	NA	NA	2003	1,242	171730	Contract of the second second	4633 \$ 358648 \$			NA NA	\$ 42,223 \$ 10,022,571		\$ 2,856,000	始创
5a Diesel Heavy Rail Transit, single track-4%	Normal days (265)	37	7 12	444	101 232	\$ 4.00	NA	NA	NA	471	471	258	3	775 \$	16.00 0			\$ 55,766			
	Peak Days (75)	51	1 12	612	139,536	\$ 4.00	NA	NA	NA	471	471	356	3	1068 \$	16.00 \$	404,928 558,144		\$ 55,766 \$ 76,867	\$ 17,095		-
	Holiday Peak Days (25) Annual	15755			232,560 43,105,680	\$ 4.00	NA NA	NA	NA NA	471 471	471	594 110022	3	1781 \$ 30067 \$				\$ 128,112 \$ 23,188,272		S 2 955 000	e suma
											e e transférie							\$ 23,188,272		\$ 2,856,000	1-3-52
5b Diesel Heavy Rail Transit, single track-6%	Normal days (265) Peak Days (75)	37			100,344 138,312	\$ 4.00 \$ 4.00		NA NA	NA NA	507 507	507 507	266 367	3	799 \$ 1102 \$		401,376 553,248		\$ 60,029 \$ 82,742			
	Holiday Peak Days (25)	85	5 12	1020	230,520	\$ 4.00	NA	NA	NA	507	507	612	3	1836 \$	16.00 \$	922,080	NA	\$ 82,742 \$ 137,904	\$ 29,376		
	Annual	15755	5 	189060	42,727,560	\$ 4.00	NA	NA	NA	507	E. B. BAR	113436	3 3	40308 \$	16.00 \$		NA	\$ 24,960,624		\$ 2,856,000	Million
6a Diesel Heavy Rail Transit, double track-4%	Normal days (265)	37			100,344			NA	NA	471	471	258	3	775 \$		401,376	NA	\$ 55,766	\$ 12,402		
	Peak Days (75) Holiday Peak Days (25)	51			138,312 230,520	\$ 4.00 \$ 4.00		NA NA	NA NA	471 471	471 471	356 594	3	1068 \$ 1781 \$	16.00 \$	553,248	NA	\$ 76,867	\$ 17,095		
	Annual	15755			42,727,560		NA	NA	NA	471		110022	A	30067 \$			the state of the state of the	\$ 128,112 \$ 23,188,272		\$ 2,856,000	CON ST
6b Diesel Heavy Rail Transit, double track-6%	Normal days (265)	37	7 12	444	100 244	\$ 4.00	NA	NA	NA	E07		266	3								
	Peak Days (75)	51	1 12	612	138,312	\$ 4.00	NA	· NA	NA	507 507	507 507	266 367	3	799 \$ 1102 \$	16.00 \$	401,376 553,248		\$ 60,029 \$ 82,742			
	Holiday Peak Days (25) Annual	85 15755			230,520 42,727,560	\$ 4.00	NA NA	NA NA	NA NA	507 507	507	612 113436	3	1836 \$	16.00 \$	922,080	NA	\$ 137,904	\$ 29,376	C 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	S. A.M.
	Comparing the second second second				72,121,000	4.00	A INA S	INPACTOR IN		507	8****Z1524	113430	5 5 5 5	40308 \$	10.00 \$	170,910,240	NA	\$ 24,960,624	ə ə,444,928	\$ 2,856,000	0200
7a Electric Heavy Rail Transit, single track-4%	Normal days (265)	37				\$ 2.68		NA	NA NA	6249	5,812	213	3	640 \$		316,519		\$ 43,006			
	Peak Days (75) Holiday Peak Days (25)	85	5 14	1190	271,320	\$ 2.68 \$ 2.68	NA NA	NA	NA	6249 6249	5,562 4,874	294 490	3	882 \$ 1471 \$		436,283 727,138		\$ 56,728 \$ 82,862			
	Annual	15755			50,289,960		NA	NA	NA	6249	a film and the	90854	3 2	72562 \$			NA	\$ 17,292,608		\$ 2,856,000	204 B
7b Electric Heavy Rail Transit, single track-6%	Normal days (265)	37			117,068	\$ 2.68	NA	NA	NA	6842	6,363	213	3	640 \$	16.00 \$	313,742	NA	\$ 47,087	\$ 10,242		
	Peak Days (75)	51			161,364			NA	NA	6842											
· · · · · · · · · · · · · · · · · · ·	Holiday Peak Days (25)	85			268,940			NA	NA	6842	6,089 5,337	294 490	3	882 \$ 1471 \$		432,456 720,759	NA NA	\$ 62,112 \$ 90,725			

5/15/01

1-70 PEIS Secondary	Screening - FGT operating of	coete	1		1	T		[T	1	1			r	Т	T	1
Total Costs	creening - 1 GT operating t	10313																
10141 00313																		
		Annual		50 yea	ar total	· · · · · ·								-			Total	l cost
		741164		00 900													TOtal	
														Track, Structure &				
			Track & Structure		Track & Structure	Number		est. life	Number of	Cost per	est. life	50 year rolling	Rolling stock	Signal Construction	Electrification			
		Operating cost	maintenance cost	Operating cost	maintenance cost		st per car	(years)	Locos	Loco	(years)	stock cost	maint. Facilities	cost		Total Capital costs	50 Years	Annualized
1a Diesel Light Rail Trans	t, single track-4%	\$ 58,398,773	\$14,448,510	\$ 2,919,938,667	\$722,425,500	and and a state of the second state of the	3,000,000	30	NA	NA	NA	\$ 675,100,000	\$108,016,000	\$1,300,000,000	NA	\$ 2,083,116,000	ber ber fam in der einen mit mehren bestehen ber bette eine	
1b Diesel Light Rail Trans		\$ 58,702,683	\$13,743,300	\$ 2,935,134,133	\$687,165,000	136 \$ 3	3,000,000	30	NA	NA	NA	\$ 679,400,000	\$108,704,000	\$530,000,000	NA	\$ 1,318,104,000	\$ 4,253,238,133	\$ 85,064,763
1c Diesel Light Rail Trans		\$ 58,611,437	\$13,746,450	\$ 2,930,571,867	\$687,322,500	135 \$ 3	3,000,000	30	NA	NA	NA	\$ 675,100,000	\$108,016,000	\$470,000,000	NA	\$ 1,253,116,000	\$ 4,183,687,867	\$ 83,673,757
2a Diesel Light Rail Trans	t, double track-4%	\$ 114,512,547	\$24,743,610	\$ 5,725,627,333	\$1,237,180,500	270 \$ 3	3,000,000	30	NA	NA	NA	\$ 1,350,200,000	\$216,032,000	\$2,340,000,000	NA	\$ 3,906,232,000	\$ 9,631,859,333	
2b Diesel Light Rail Trans	·	\$ 115,120,365	\$26,007,318	\$ 5,756,018,267	\$1,300,365,900	272 \$ 3	3,000,000	30	NA	NA	NA	\$ 1,358,800,000	\$217,408,000	\$840,000,000	NA	\$ 2,416,208,000	\$ 8,172,226,267	\$ 163,444,525
2c Diesel Light Rail Trans		\$ 114,937,875	\$24,743,610	the second	\$1,237,180,500	270 \$ 3	3,000,000	30	NA	NA	NA	\$ 1,350,200,000	\$216,032,000	\$740,000,000	NA	\$ 2,306,232,000	\$ 8,053,125,733	\$ 161,062,515
3a Electric Light Rail Tran		\$ 53,023,875	\$19,264,680	NEWSCON, SPORT LUTING THIS PLACE TO AN A TOTAL TO AND	\$963,234,000	132 \$ 2	2,600,000	40	NA	NA	NA	\$ 430,430,000	\$105,952,000	\$1,300,000,000	\$ 210,000,000	\$ 2,046,382,000	\$ 4,697,575,762	\$ 93,951,515
3b Electric Light Rail Tran		\$ 53,507,137	the Construction of the Construction of Association	\$ 2,675,356,844	\$916,220,000	131 \$ 2	2,600,000	40	NA	NA	NA	\$ 424,840,000	\$104,576,000	\$530,000,000	\$ 210,000,000	\$ 1,269,416,000	\$ 3,944,772,844	\$ 78,895,457
3c Electric Light Rail Tran		\$ 53,437,955		\$ 2,671,897,769	\$916,430,000	131 \$ 2	and the subscript in a section of	40	NA	NA	NA	\$ 424,840,000	\$104,576,000	\$470,000,000	\$ 210,000,000			
4a Electric Light Rail Tran		\$ 102,224,211		\$ 5,111,210,574		265 \$ 2		40		NA	NA	\$ 860,860,000	\$211,904,000	\$2,340,000,000		\$ 3,812,764,000		
4b Electric Light Rail Tran		\$ 103,081,933		\$ 5,154,096,652		261 \$ 2		40		NA	NA	\$ 849,680,000	\$209,152,000	\$840,000,000	and the second se	\$ 2,298,832,000		
4c Electric Light Rail Tran		\$ 102,956,839	the second address over the after the	\$ 5,147,841,927	a a company atta company attacts	261 \$ 2	Anteria delar	40		NA	NA	\$ 849,680,000	\$209,152,000	\$740,000,000	The second is strated by strate	An el al el el el entre a arten menter el a	and the set of the set	
5a Diesel Heavy Rail Tran		\$ 203,748,068	all a second and the second and the second second second	\$ 10,187,403,400	\$722,425,500	503 \$ 3	The letter of the second second second	30	NA	NA	NA	\$ 2,515,500,000	\$402,480,000	\$1,300,000,000	NA	The second se	State and the state of a section of the section of the section of	the second s
5b Diesel Heavy Rail Tran		\$ 204,171,792	A CONTRACTOR OF A CONTRACTOR O	\$ 10,208,589,600	\$687,165,000	519 \$ 3	and the second second	30	NA	NA	NA	\$ 2,592,900,000	\$414,864,000	\$530,000,000	NA		\$ 13,746,353,600	
6a Diesel Heavy Rail Tran		\$ 202,235,588		\$ 10,111,779,400		503 \$ 3		30		NA	NA	\$ 2,515,500,000	\$402,480,000	\$2,340,000,000	NA		\$ 15,369,759,400	
6b Diesel Heavy Rail Tran	and an and the second	\$ 204,171,792	the second second second	\$ 10,208,589,600	the statistical data and the state of the state	519 \$ 3	Construction of the second	30	NA	NA	NA	\$ 2,592,900,000	\$414,864,000	\$840,000,000	NA		\$ 14,056,353,600	
7a Electric Heavy Rail Tra		\$ 159,286,685	the second se	\$ 7,964,334,227	\$963,234,000	485 \$ 2	and the second	40	NA	NA	NA	\$ 1,574,982,500	\$387,688,000	\$1,300,000,000	\$ 220,000,000			
7b Electric Heavy Rail Tra		\$ 159,745,415	the second second second second second second	\$ 7,987,270,726	\$916,220,000	485 \$ 2		40	NA	NA	NA	\$ 1,574,982,500	\$387,688,000	\$530,000,000	\$ 220,000,000			
8a Electric Heavy Rail Tra		\$ 157,628,387		\$ 7,881,419,371	\$1,649,574,000	485 \$ 2	-1 1	40	NA	NA	NA	\$ 1,574,982,500	\$387,688,000	\$2,340,000,000	and the second sec	\$ 4,712,670,500		
8b Electric Heavy Rail Tra	The second state in the second state of the se	\$ 157,929,753	\$32,983,920	\$ 7,896,487,649	\$1,649,196,000	485 \$ 2	2,600,000	40	NA	NA	NA	\$ 1,574,982,500	\$387,688,000	\$840,000,000	\$ 410,000,000	\$ 3,212,670,500	\$ 11,109,158,149	\$ 222,183,163
The Provide Alex Contraction of the Alexandra State of the Ale	ssenger RR, single track-4%	stalled																
	ssenger RR, single track-6% ssenger RR, double track-4%	stalled stalled	an anna thair an ann				a profile a later			CHARLEN HE HALL								
	ssenger RR, double track-6%	stalled																
The ball the provident state and the ball of the ball of the state of the state of the	assenger RR, single track-4%	stalled	California Scholande Latitude		and an and a second	anan in saadees ar	CALTER LAND	2592 STAN 1974		hereastaning a		Participation and a state		nen erstellen en stationen p	nas a merci ante america da a	2 CARDING STRATEGING	and the second second second	and constant in the
次に記念れたらいないたというというないでも、からうないないこと	assenger RR, single track-4%	stalled							Sall State									
	assenger RR, double track-4%	stalled			1.2.12.12.12.12.12.12.12.12.12.12.12.12.	Martin and Martin and	140000 6.05	and the state						和自己的 的复数动力的 化		的時代的時代的政治的行行	出现 医热口 医胆管 医上的	。 一部的 一部
	assenger RR, double track-6%	stalled															-	
the second	assenger RR, single track-4%	\$ 191,691,015	\$19,264,680	\$ 9,584,550,737	\$963,234,000	353 \$ 2	2 800 000	40	NA	NA	NA	\$ 1,234,100,000	\$282,080,000	\$1,300,000,000	\$ 220,000,000	\$ 2 02C 1 20 000	£ 40 000 700 707	0.000 444.045
	assenger RR, single track-6%	\$ 192,552,238	CARACTER STREET, STREET	\$ 9,627,611,896	\$916,220,000	357 \$ 2	Same and the second	40	NA	NA	NA	\$ 1,249,150,000	\$285,520,000	\$530,000,000	\$ 220,000,000	The set of the second sec		\$ 252,414,615
a second s	assenger RR, double track-4%	\$ 190,125,597	the state of the second state of the	\$ 9,506,279,856	\$1,733,821,200	353 \$ 2	a state of the second second	40	NA	NA I	NA	\$ 1,234,100,000	\$285,520,000	\$2,340,000,000	and the state of the second state of the	\$ 2,284,670,000 \$ 4,276,180,000		\$ 238,245,638
	assenger RR, double track-6%	\$ 190,909,067	\$32,983,920		\$1,649,196,000	353 \$ 2		40	NA	NA	NA	\$ 1,234,100,000	\$282,080,000	\$840,000,000		\$ 2,776,180,000		
15a Electric Conv. Monoral	an internet of the second se	\$ 199,991,746	the second s	\$ 9,999,587,288	\$1,733,821,200	791 \$ 1	Participation of the	25	NA	NA	NA	\$ 1,582,400,000	\$632,960,000	\$1,824,306,818	\$ 400,000,000	I wants and white they contrained a test the samely	\$ 14,439,254,106	
15b Electric Conv. Monoral		\$ 200,427,294		\$ 10,021,364,700	\$1,649,196,000	785 \$ 1	Address of the second of the	25	NA	NA	NA	\$ 1,570,933,333	\$628,373,333	\$1,735,265,152	\$ 400,000,000	A STATE OF THE AND A STATE OF THE ADDRESS OF THE ADDRES	The state of the state of the state of the	
and the second	AGS, double guideway-Hwy	\$ 199,972,372	the second second second second second second second	\$ 9,998,618,580	\$1,649,574,000	780 \$ 1	and the second	25	NA	NA	NA	\$ 1,559,466,667	\$623,786,667	\$1,735,662,879	\$ 400,000,000	a second second second second second second second		and the second second a state of the second
16 CIFGA Monorail (Highw		\$ 279,057,777	the state will be an a state of the state of the state of the	\$ 13,952,888,832	a second s	969 \$ 1	and the second of the second s	25	NA	NA I	NA	\$ 2.326.690.909	\$775,563,636	\$1,824,306,818		\$ 5,326,561,364		
	Pk. Diesel Loco. hauled Psgr RR	\$ 772,800		\$ 38,640,000	NA		,800,000	50	2	4100000		\$ 10,800,100	\$4,800,000	NA	\$ 400,000,000 NA	\$ 15,600,100		
18 Moffat Tunnel to Glenw	ood Diesel Loco, hauled Psgr RR	\$ 1,545,600	All a real and the second a second	\$ 77,280,000	NA	and a well a second standard and a second stand	,800,000	50	2	4100000		\$ 10,800,100	\$4,800,000	NA	NA	\$ 15,600,100	and a second	and an an and a mark the state of any
		1		1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	a secolar of a secolar secolar		1	and the second	1000 100 0 1000 1		CO. CO.	+	¢1,000,000	and the second second	an provide a Marchael and	4 10,000,100	\$ 32,000,100	φ 1,007,002
						/ /	AGS costs											
Length (in feet)		FGT COST SUMM	ARY - Alignment De	pendent costs			er mile	per foot										
Hwy 458215							0,000,000											1
4% 481617																		
			Single Track w/															
6% 458110		Alignment	passing sidings	crossovers	AGS						-							
factor for double 1.8																		
Maintenance costs, (per foot		Highway (>6% grad			\$ 1,735,662,879													1
Track & Signal \$30		Corridor 6% (<6% g			\$ 1,735,265,152													
Track, Sig. & Ele \$40		4% (<4% grades pr	r \$1,300,000,000	\$2,340,000,000	\$ 1,824,306,818													
R.S. Maint. Facil., (per car)	\$800,000)		12														
Fare Collection system	\$5,000,000																	

Capital cost per mile 5 116,419 5 14,007,116 5 14,007,116 5 14,007,140 5 14,005,435 5 23,736,781,40 5 24,222,79 5 24,222,79 5 24,4135 5 31,609,5442 5 35,420,698 5 32,106,744 5 35,420,698 5 44,741,442 5 44,741,442 5 44,741,442 5 44,735 5 44,741,442 5 44,735 5 44,741,442 5 44,735 5 44,741,442 5 44,735 5 44,741,442 5 44,735 5 44,735 5 44,741,442 5 44,735 5 44,735 5 44,741,442 5 5 45,405 5 5 442,305 5 5 45,405 5 5 44,741,442 5 5 5 45,405 5 5 45,405 5 5 45,405 5 5 44,741,442 5 5 45,405 5 5 45,405 5 5 45,405 5 5 45,405 5 5 45,405 5 5 45,405 5 5 44,741,442 5 5 5 45,405 5 5												
Total Cost 50 years 5 54,040,100 5 54,040,100 5 3,881,313,769 5 3,981,313,769 5 3,944,772,844 5 3,944,772,844 5 3,944,772,844 5 3,944,772,844 5 3,944,772,844 5 4,183,687,987 5 3,944,772,844 5 4,183,687,987 5 4,183,687,987 5 11,457,099,4152 5 11,457,099,4152 5 11,457,099,4152 5 11,457,099,4152 5 11,457,099,4152 5 11,457,099,4152 5 11,457,099,158,149 5 11,457,099,158,149 5 11,457,099,158,149 5 13,726,533,341 5 13,726,533,341 5 13,726,533,341 5 13,726,533,341 5 13,726,533,341 5 13,746,533,341 5	\$ 3,881,313,769 \$ 3,944,772,844 \$ 4,183,687,867							\$ 12,306,633,344 \$ 12,584,089,871	\$ 12,630,730,737 \$ 13,732,734,792	\$ 13,746,353,600	\$ 13,766,836,518 \$ 13,767,450,856	5 13,/D1,438,030
Total Capital 5 15,600,100 5 15,600,100 5 15,600,100 5 1,209,416,000 5 1,209,416,000 5 1,209,416,000 5 2,046,382,000 5 2,046,382,000 5 2,046,16,000 5 2,046,16,000 5 2,046,16,000 5 2,046,16,000 5 2,046,16,000 5 2,146,000 5 2,146,000 5 2,146,000 5 3,147,764,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000 5 3,1416,000	416,000 116,000	1,318,104,000 2,046,382,000	2,083,116,000 2,198,832,000 2,298,832,000	2,306,232,000 2,416,208,000 3.812.764,000	3,906,232,000 2,722,670,500	2,122,670,500 3,202,670,500 3,492,670,500	3,492,670,500 2,294,670,000 2,754,4670,000		\$ 3,046,180,000 \$	\$ 3,537,764,000	\$ 3,745,471,818 3 * 1 261 180 000	* 4,201,100,000
50 years 50 years 50 years 38,640,000 77,280,000 3,588,327,769 3,591,576,844 3,591,576,844 3,591,576,844 3,591,576,844 3,591,576,844 3,591,576,844 3,517,762 3,617,894,367 3,617,894,367 3,617,894,367 3,617,894,367 3,617,894,367 3,617,894,367 3,642,364,167 6,797,415,927 6,984,074,167 8,905,324,662 8,907,568,371 9,530,993,371 9,544,686 10,547,769 3,642,364,167 6,797,415,927 6,984,107 10,547,769 3,642,364,167 10,547,769 3,640,000 35,643,641 11,173,404,101 10,547,763 3,644,074 8,903,490,726 11,670,580,700 11,670,580,700 3,644,377 11,670,580,700 3,644,377 11,670,580,700 3,644,377 11,670,580,700 3,644,377 11,670,580,700 3,644,377 11,1733,408,485 6,962,3044,167	3,591,576,844 3,617,894,367 3,617,894,367	3,622,299,133 3,614,427,762	3,642,364,167 6,797,415,927 6,803,292,652	6,984,074,233 7,056,384,167 6.760.784,574	6,962,807,833 8.903,490.726	0,300,490,720 9,545,683,649 8 927 568,227	8,927,568,227 10,543,831,896 44,404,640,244	11,194,649,344 9,530,993,371	10,547,784,737 11,648,192,580	10,895,754,600	11,670,560,700 11 240 101 056	11,240,101,000
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Sort by OM Monthan Tume Ito Winter Pk. Diesel Loco. hauled Psgr 10. Monthan Tume Ito Winter Pk. Diesel Loco. hauled Psgr 13. Monthan Tumesit, single track-fills, 23. Electric Light Rail Transit, single track-fills, 24. Electric Light Rail Transit, single track-fills, 24. Electric Light Rail Transit, single track-fills, 25. Electric Light Rail Transit, double track-fills, 25. Electric Light Rail Transit, double track-fills, 26. Diesel Light Rail Transit, double track-fills, 27. Diesel Light Rail Transit, double track-fills, 28. Diesel Light Rail Transit, double track-fills, 29. Diesel Light Rail Transit, single track-fills, 28. Diesel Light Rail Transit, single track-fills, 29. Diesel Light Rail Transit, single track-fills, 39. Electric Heavy Rail Transit, single track-fills, 30. Diesel Light Rail Transit, single track-fills, 30. Electric Light Rail Transit, single track-fills, 30. Electric Light Rail Transit, single track	ecuto Light Rail Transit, sirigle u ecorriny sotric Light Rail Transit, single track-6% ssel Light Rail Transit, single track-Hwy	əsel Light Rail Transit, single track-6% əctric Light Rail Transit, single track-4%	ssel Light Rail Transit, single track-4% sctric Light Rail Transit, double track-Hwy sctric Light Rail Transit, double track-6%	esel Light Rail Transit, double track-Hwy seel Light Rail Transit, double track-6% cotric Light Rail Transit, double track-4%	Electric Eight Rail Transit, double uack-4% Diesel Light Rail Transit, double track-4% Electric Heavy Rail Transit, single track-6%	ould reavy nem ransm, angue ueun yo octric Heavy Rail Transit, double track-6% antric Heavy Pail Transit sincle track-4%	sctric Heavy Kall Iransit, single track-47% sctric Multiple Unit Passenger RR, single track-6%	k-4%	sctric Multiple Unit Passenger RR, single track-4% sctric Conv. Monorail AGS, double guideway-Hwy		ectric Conv. Monorail AGS, double guideway-6%	SCITIC INILIIPIE UTILI FASSELIYEL INN, WUMUE VAVI - 1
Solution	280 100	6 B	4 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2c D 2b D 4a	7b D		30 E	4b E Ba E	3a E 5c E		15b E	1 1

					Andrew workson and and a
13,845,854,106	14,056,353,600	14,405,383,400	15,369,759,400	18,406,941,105	
3,846,266,818	3,847,764,000	4,217,980,000 \$	5,257,980,000 \$	4,454,052,273 \$	
11,733,408,488	11,445,486,600 \$	10,909,828,900 \$	11,412,145,300 \$	15,686,710,032 \$	
¢	\$	\$	୫	\$	
Electric Conv. Monorali, double guideway-4%	Diesel Heavy Rail Transit, double track-6%	Diesel Heavy Rail Transit, single track-4%	Diesel Heavy Rail Transit, double track-4%	CIFGA Monorail (Highway only)	
15a	6b	Sa	6a	16	



Table 4

RTT Analysis Results

		Gallons	KwHr		Diesel	Electric		Total Total Annual Total Cost/ Total Cost/	Total	Cost/ T	otal Cost/
Alternative	/e	4.5	S	\$	1.60 \$	0.10		Veh Miles Vehicle Mile Seat Mile	Vehicl	e Mile S	eat Mile
-	Bus and Improved Van in mixed traffic	4,080,000		69	6,528,000 \$	į	\$ 6,528,000	18,353,186	\$	0.356	0.008
0	Diesel Bus in marked HOV lane, peak	4,040,000	1	\$	6,464,000 \$	3	\$ 6,464,000	18,199,065	\$	0.355	0.008
ŝ	Diesel Bus in marked HOV lane, both	4,040,000		\$	6,464,000 \$	Ì	\$ 6,464,000	18,199,065	s	0.355	0.008
4	Diesel Bus in separated HOV Lanes, peak	4,040,000	4	69	6,464,000 \$	i.	\$ 6,464,000	18,199,065	5	0.355	0.008
2	Diesel Bus in separate transitway, peak	4,040,000	a	\$	6,464,000 \$	1	\$ 6,464,000	18,199,065	5	0.355	0.008
9	Diesel Bus in separate transitway, both	4,040,000	¢	69	6,464,000 \$	i.	\$ 6,464,000	18,199,065	\$	0.355	0.008
7	Diesel Bus in guided transitway, peak	4,040,000	c	69	6,464,000 \$	•	\$ 6,464,000	18,199,065	\$	0.355	0.008
8	Diesel Bus in guided transitway, both	4,040,000	¢	69	6,464,000 \$	•	\$ 6,464,000	18, 199,065	\$	0.355	0.008
6	Diesel Bus in guided transitway, BRT stations	4,040,000	ı	67	6,464,000 \$	•	\$ 6,464,000	18,199,065	\$	0.355	0.008
10	Dual Mode Bus in separate transitway, peak	2,530,000	33,900,000	69	4,048,000 \$	3,390,000	\$7,438,000	18,166,454	\$	0.409	0.009
11	Dual Mode Bus in separate transitway, both	2,530,000	33,900,000	69	4,048,000 \$	3,390,000	\$ 7,438,000	18,166,454	69	0.409	0.009
12	Dual Mode Bus in guided transitway, peak	2,530,000	33,900,000	69	4,048,000 \$	3,390,000	\$ 7,438,000	18,166,454	69	0.409	0.009
13	Dual Mode Bus in guided transitway, both	2,530,000	33,900,000	69	4,048,000 \$	3,390,000	\$ 7,438,000	18,166,454	69	0.409	0.009
14	Dual Mode Bus in guided transitway, BRT stations	2,530,000	33,900,000	ŝ	4,048,000 \$	3,390,000	\$ 7,438,000	18,166,454	\$	0.409	0.009
15	Electric Bus in separate transitway, both	3,040,000	46,070,000	69	4,864,000 \$	4,607,000	\$ 9,471,000	22,881,172	\$	0.414	0.009
16	Electric Bus in guided transitway, both	3,040,000	46,070,000	69	4,864,000 \$	4,607,000	\$ 9,471,000	22,881,172	69	0.414	0.009
17	Electric Bus in guided transitway, BRT stations	3,040,000	46,070,000	\$	4,864,000 \$	4,607,000	\$ 9,471,000	22,881,172	\$	0.414	0.009
Note: El	Note: Electric bus alternatives has diesel due to feeder system										

Annual Cost

Fuel Consumption

Note: Electric bus alternatives has diesel due to feeder system

5/29/01 RTToperations2 Fuel Consumption Summary

MAIN LINE OPERATIONS

Capital Costs

								apital (main line oper							Annualized		Total
				Vehicles (main			Rigi	t of Way Infrastruct	Ire		Facilities	1	Total Capital	Vehicles	ROW	Facilities	Annualized
Alternative	Description	Туре	Max Vehicles	Total Plus 20%	Unit Price	Total Cost	Total	Electrification	Total	Operations	Transit Centers	Total		12 4.0%	25 4.2%	25 Life 4.2% Real Interest	Annganzeg
1	Bus and Improved Van in mixed traffic	Mixed	97	116 \$	350,000 \$	40,600,000	\$-	\$ - \$	i -	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 101,600,000	\$4,300,000	6 -	\$4,000,000	\$8,300,00
2	Diesel Bus in marked HOV lane, peak	HOV/Transit	97	116 \$	350,000 \$	40,600,000	\$ 422,913,920	\$-9	422,913,920	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 524,513,920	\$4,300,000	\$ 27,600,000	\$4,000,000	\$35,900,00
3	Diesel Bus in marked HOV lane, both	HOV/Transit	97	116 \$	350,000 \$	40,600,000	\$ 487,510,880	\$-9	487,510,880	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 589,110,880	\$4,300,000 \$	31,900,000	\$4,000,000	\$40,200,00
4	Diesel Bus in separated HOV Lanes, peak	HOV/Transit	97	116 \$	350,000 \$	40,600,000	\$ 682,903,280	\$ - \$	682,903,280	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 784,503,280	\$4,300,000 \$	44,600,000	\$4,000,000	\$52,900,00
5	Diesel Bus in separate transitway, peak	HOV/Transit	97	116 \$	350,000 \$	40,600,000	\$570,429,360	5	570,429,360	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 672,029,360	\$4,300,000 \$	37,300,000	\$4,000,000	\$45,600,00
6	Diesel Bus in separate transitway, both	HOV/Transit	97	116 \$	350,000 \$	40,600,000	\$682,903,280	\$	682,903,280	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 784,503,280	\$4,300,000 \$	44,600,000	\$4,000,000	\$52,900,00
7	Diesel Bus in guided transitway, peak	Guide	97	116 \$	350,000 \$	40,600,000	\$457,384,680	\$	457,384,680	\$ 36,000,000 \$	25,000,000	\$ 61,000,000	\$ 558,984,680	\$4,300,000 \$	29,900,000	\$4,000,000	\$38,200,00
8	Diesel Bus in guided transitway, both	Guide	97	116 \$	350,000 \$	40,600,000	\$537,560,120	\$	537,560,120	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 639,160,120	\$4,300,000 \$	35,100,000	\$4,000,000	\$43,400,00
9	Diesel Bus in guided transitway, BRT stations	Guide	97	116 \$	350,000 \$	40,600,000	\$549,560,120	\$	549,560,120	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 651,160,120	\$4,300,000 \$	35,900,000	\$4,000,000	\$44,200,00
10	Dual Mode Bus in separate transitway, peak	HOV/Transit	97	116 \$	1,000,000 \$	116,000,000	\$570,429,360	\$ 100,000,000 \$	670,429,360	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 847,429,360	\$12,400,000 \$	43,800,000	\$4,000,000	\$60,200,00
11	Dual Mode Bus in separate transitway, both	HOV/Transit	97	116 \$	1,000,000 \$	116,000,000	\$682,903,280	185,000,000 \$	867,903,280	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 1,044,903,280	\$12,400,000 \$	56,700,000	\$4,000,000	\$73,100,00
12	Dual Mode Bus in guided transitway, peak	Guide	97	116 \$	1,000,000 \$	116,000,000	\$457,384,680	100,000,000 \$	557,384,680	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 734,384,680	\$12,400,000 \$	36,400,000	\$4,000,000	\$52,800,00
13	Dual Mode Bus in guided transitway, both	Guide	97	116 \$	1,000,000 \$	116,000,000	\$537,560,120	185,000,000 \$	722,560,120	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 899,560,120	\$12,400,000 \$	47,200,000	\$4,000,000	\$63,600,00
14	Dual Mode Bus in guided transitway, BRT stations	Guide	97	116 \$	1,000,000 \$	116,000,000	\$549,560,120	185,000,000 \$	734,560,120	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 911,560,120	\$12,400,000 \$	48,000,000	\$4,000,000	\$64,400,00
15	Electric Bus in separate transitway, both	HOV/Transit	97	116 \$	700,000 \$	81,200,000	\$1,038,160,080	235,000,000 \$	1,273,160,080	\$ 36,000,000 \$	25,000,000	61,000,000	\$ 1,415,360,080	\$6,400,000 \$	83,200,000	\$4,000,000	\$93,600,000
16	Electric Bus in guided transitway, both	Guide	97	116 \$	700,000 \$	81,200,000	\$847,057,320	235,000,000 \$	1,082,057,320	\$ 36,000,000 \$	25,000,000	61,000,000	1,224,257,320	\$6,400,000 \$	70,700,000	\$4,000,000	\$81,100,000
17	Electric Bus in guided transitway, BRT stations	Guide	97	116 \$	700,000 \$	81,200,000	\$860,557,320	235,000,000 \$	1,095,557,320	\$ 36,000,000 \$	25,000,000 \$	61,000,000	1,237,757,320	\$6,40 <u>0</u> ,000 \$	71,600,000	\$4,000,000	\$82,000,000

FEEDER OPERATIONS

(from feeder.xls/feeder ops)

Capital			Annualized (rounded)
Fixed Route			
<u>Vehicles</u>			
20% Total			
21		128	
Jnit	\$	275,000	
<u>Fotal</u>	\$	35,310,000	\$ 3,760,000
<u>Dps Facilities</u> 25 year	fe		
/ail	\$	7,500,000	
Summit		6,500,000	
daho/else		1,250,000	
<u>Fotal</u>	\$	15,250,000	\$997,000
Other life=10 years			
Electronics	\$	3,191,000	
Equipment		1,276,500	
otal	\$	4,467,500	\$556,000
otal Fixed Route	\$	55,027,500	\$ 5,313,000
ADA Paratransit			
Life			
/ehicles 4	\$	3,124,000	\$865,000
Equipment 10	\$	3,021,000	\$376,000
acility 25	\$	5,000,000	\$327,000
otal ADA	\$	11,145,000	\$1,568,000
ll Cap	\$	66,172,500	\$ 6,881,000
DD Feeder for Trolley Bus Options Capital			
Vehicles		24 200 000	co oco oco
Facility and Other		31,200,000	\$3,363,000
Facinity and Other		9,500,000	\$621,000
Total		40,700,000	\$3,984,000
otal for TB Options			\$ 10,865,000

1 of 1

Total Cost Summary

				Main	Line Operations		1	Fe	eder Operations		Totals	
			Total	Capital Cost	Annualized	Operating	Total	Total	Annualized Operations	Annual	Annual	Total
			Capital	per mile		Costs	Annualized	Capital		Capital	Operations	Annual
Alternative	Description	Туре										
4	Bue and Improved V(ap in mixed troffic	Mixed	\$ 101,600,000	\$ 1,181,395	\$8,300,000 \$	14,870,000	\$23,170,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$15,181,000	\$ 32,920,000	\$48,101,000
1	Bus and Improved Van in mixed traffic	HOV/Transit	\$ 524,513,920		\$35,900,000 \$	12,950,000	\$48,850,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$42,781,000		\$73,781,000
2	Diesel Bus in marked HOV lane, peak Diesel Bus in marked HOV lane, both	HOV/Transit	\$ 589.110.880	\$ 6,850,127	\$40,200,000 \$	12,950,000	\$53,150,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$47.081.000		\$78,081,000
3	Diesel Bus in separated HOV Lanes, peak	HOV/Transit	\$ 784,503,280		\$52,900,000 \$	12,950,000	\$65,850,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$59,781,000		\$90,781,000
4	Diesel Bus in separate transitway, peak	HOV/Transit	\$ 672,029,360		\$45,600,000 \$	12,950,000	\$58,550,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$52,481,000		\$83,481,000
5	Diesel Bus in separate transitway, beak	HOV/Transit	\$ 784,503,280	\$ 9,122,131	\$52,900,000 \$	12,950,000	\$65,850,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$59,781,000		\$90,781,000
7	Diesel Bus in guided transitway, peak	Guide	\$ 558,984,680		\$38,200,000 \$	12,950,000	\$51,150,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$45,081,000	\$ 31,000,000	\$76,081,000
8	Diesel Bus in guided transitway, both	Guide	\$ 639,160,120		\$43,400,000 \$	12,950,000	\$56,350,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$50,281,000	\$ 31,000,000	\$81,281,000
9	Diesel Bus in guided transitway, BRT stations	Guide	\$ 651,160,120	· · · · · · · · · · · · · · · · · · ·	\$44,200,000 \$	12,950,000	\$57,150,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$51,081,000	\$ 31,000,000	\$82,081,000
10	Dual Mode Bus in separate transitway, peak	HOV/Transit	\$ 847,429,360		\$60,200,000 \$	12,190,000	\$72,390,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$67,081,000	\$ 30,240,000	\$97,321,000
11	Dual Mode Bus in separate transitway, both	HOV/Transit	\$ 1,044,903,280	\$ 12,150,038	\$73,100,000 \$	12,190,000	\$85,290,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$79,981,000	\$ 30,240,000	\$110,221,000
12	Dual Mode Bus in guided transitway, peak	Guide	\$ 734,384,680	\$ 8,539,357	\$52,800,000 \$	12,190,000	\$64,990,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$59,681,000	\$ 30,240,000	\$89,921,000
13	Dual Mode Bus in guided transitway, both	Guide	\$ 899,560,120	\$ 10,460,001	\$63,600,000 \$	12,190,000	\$75,790,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$70,481,000	\$ 30,240,000	\$100,721,000
14	Dual Mode Bus in guided transitway, BRT stations	Guide	\$ 911,560,120	\$ 10,599,536	\$64,400,000 \$	12,190,000	\$76,590,000 \$	66,200,000	\$6,881,000 \$ 18,050,000	\$71,281,000	\$ 30,240,000	\$101,521,000
15	Electric Bus in separate transitway, both	HOV/Transit	\$ 1,415,360,080	\$ 16,457,675	\$93,600,000 \$	8,660,000	\$102,260,000 \$	106,872,500	\$10,865,000 \$ 31,050,000	\$104,465,000	\$ 39,710,000	\$144,175,000
16	Electric Bus in guided transitway, both	Guide	\$ 1,224,257,320	\$ 14,235,550	\$81,100,000 \$	8,660,000	\$89,760,000 \$	106,872,500	\$10,865,000 \$ 31,050,000	\$91,965,000		\$131,675,000
17	Electric Bus in guided transitway, BRT stations	Guide	\$ 1,237,757,320	\$ 14,392,527	\$82,000,000 \$	8,660,000	\$90,660,000 \$	106,872,500	\$10,865,000 \$ 31,050,000	\$92,865,000	\$ 39,710,000	\$132,575,000

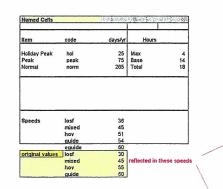
Sorted by C	apital Costs per mile		Total Capital	Capital Cost per mile
1	Bus and Improved Van in mixed traffic	Mixed	\$101,600,000	\$1,181,395
2	Diesel Bus in marked HOV lane, peak	HOV/Transit	\$524,513,920	\$6,098,999
7	Diesel Bus in guided transitway, peak	Guide	\$558,984,680	\$6,499,822
3	Diesel Bus in marked HOV lane, both	HOV/Transit	\$589,110,880	\$6,850,127
8	Diesel Bus in guided transitway, both	Guide	\$639,160,120	\$7,432,094
9	Diesel Bus in guided transitway, BRT stations	Guide	\$651,160,120	\$7,571,629
5	Diesel Bus in separate transitway, peak	HOV/Transit	\$672,029,360	\$7,814,295
12	Dual Mode Bus in guided transitway, peak	Guide	\$734,384,680	\$8,539,357
4	Diesel Bus in separated HOV Lanes, peak	HOV/Transit	\$784,503,280	\$9,122,131
6	Diesel Bus in separate transitway, both	HOV/Transit	\$784,503,280	\$9,122,131
10	Dual Mode Bus in separate transitway, peak	HOV/Transit	\$847,429,360	\$9,853,830
13	Dual Mode Bus in guided transitway, both	Guide	\$899,560,120	\$10,460,001
14	Dual Mode Bus in guided transitway, BRT stations	Guide	\$911,560,120	\$10,599,536
11	Dual Mode Bus in separate transitway, both	HOV/Transit	\$1,044,903,280	\$12,150,038
16	Electric Bus in guided transitway, both	Guide	\$1,224,257,320	\$14,235,550
17	Electric Bus in guided transitway, BRT stations	Guide	\$1,237,757,320	\$14,392,527
15	Electric Bus in separate transitway, both	HOV/Transit	\$1,415,360,080	\$16,457,675

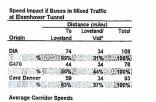
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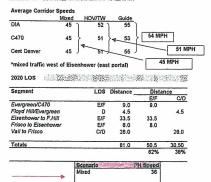
5/29/01 RTToperations2 ROW Costs TranSystems

Origin	Pattern Days/Year	Revenu O-W	RT RT	Mixed	Running Ti HOV	mes (Hours) Guide	Equide	Ave Freque Max	Base	Vehicle Max	s in Servi	ce Max/Base	Max Mixed	Vehs for HOV	Frequency Guide	Found		nnual Rever	Hours	Ec.12
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	4	118	236	5.2	4.6	4.4	2.9	60	60	11	11	100%	5	4	4	2	23,850	14,310 19,080	14,310 19,080	9,540 9,540
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eak	75			5. X																
	1 2	35 59	70 118	1.6 2.6	1.4 2.3	1.3 2.2	0.7	60 60	60 60	2	2	100%	1 2	1 2	1 2	1	1,350	1,350 2,700	1,350 2,700	1,350 1,350
	3	75 103	150 206	3.3	2.9 4.0	2.8 3.8	2.0	60 60	60 60	1	1 7	100%	3	2	2	2	4,050 5,400	2,700	2,700 4,050	2,700
· · · · · · · · · · · · · · · · · · ·										11			10	9	8	6	13,500	12,150	10,800	8,100
lormal	265																			
	1	59 75	118 150	2.6 3.3	2.3 2.9	2.2 2.8	1.5	120 120	120	1	1	100%	1	1	1	1	4,770	4,770	4.770	4.770
	3	103	206	4.6	4.0	3.8	2.9	120	120	3	1	100% 100%	1 2	2	1	1	4,770 9,540	4,770 9,540	4,770 4,770	4,770
entral Denver To							*****			5			4	4	3	3	19,080	19,080	14,310	14,310
										17							38,230	36,055	29,485	25,235

	1.001 001	nsumption		Mäeage					
				Mair					Fe
	Applicat	ion	Rev Hrs	Veh Hrs 33%	Speed	Miles	Revenue Hrs I-70	Trolley	Total
	Diesel	Mixed	198,230	263,646	45	11.864.066	270.380		270.38
	Dictor	HOV/TW	172.637	229,607	51	11,709,945	270,380		270.30
		Guide	172,637	229,607	51	11,709,945	270,380		270,30
	Dual	HOV/TW	162.592	216.247	54	11,677,334	270,380		270.38
		Guide	162,592	216,247	54	11,677,334	270,380		270,38
	Electric	HOV/TW	115,472	153,577	60	9,214,639	270,380	132,915	403.29
		Guide	115,472	153,577	60	9,214,639	270,380	132,915	403,29
					Miles			Fu	
	Applicati	on	Main Diesel	Electric	Feeder Diesel	Diesel	tal Electric	Gallons 4.5	Kw
	Diesel	Mixed	11,864,066		6,489,120	18,353,186		4,080,000	
		HOV/TW	11,709,945		6,489,120	18,199,065	-	4,040,000	-
		Guide	11,709,945		6,489,120	18,199,065	•	4,040,000	-
	Dual	HOV/TW	4,897,591	6,779,743	6,489,120	11,386,711	6,779,743	2,530,000	33,900,00
		Guide	4,897,591	6,778,743	6,489,120	11,386,711	6,779,743	2,530,000	33,900,00
	Electric	HOV/TW	-	9,214,639	13,666,533	13,666,533	9,214,639	3,040,000	46.070.00
		Guide	-	9,214,639	13,666,533	13,666,533	9,214,639	3,040,000	46,070,00
	Dual Alloc Segment	ation of elec	tric/diesel DIA	Cen Denver	c470	Wtd	%	·	
	to C470		30	Cen Denver 15	C470	19	15%		42
ic		senhower	74	74	74	74	58%		
el	Eisenhow	er Vall	34	34	34	34	27%		
			138 56%	123 18%	108 26%	127	100%		
		Rev Hrs	%						
	DIA	90,707	56%						
			18%						
	Cen Den	29,485	18%						
	Cen Den C470	29,485 42,400	26%						
		42,400	26%						

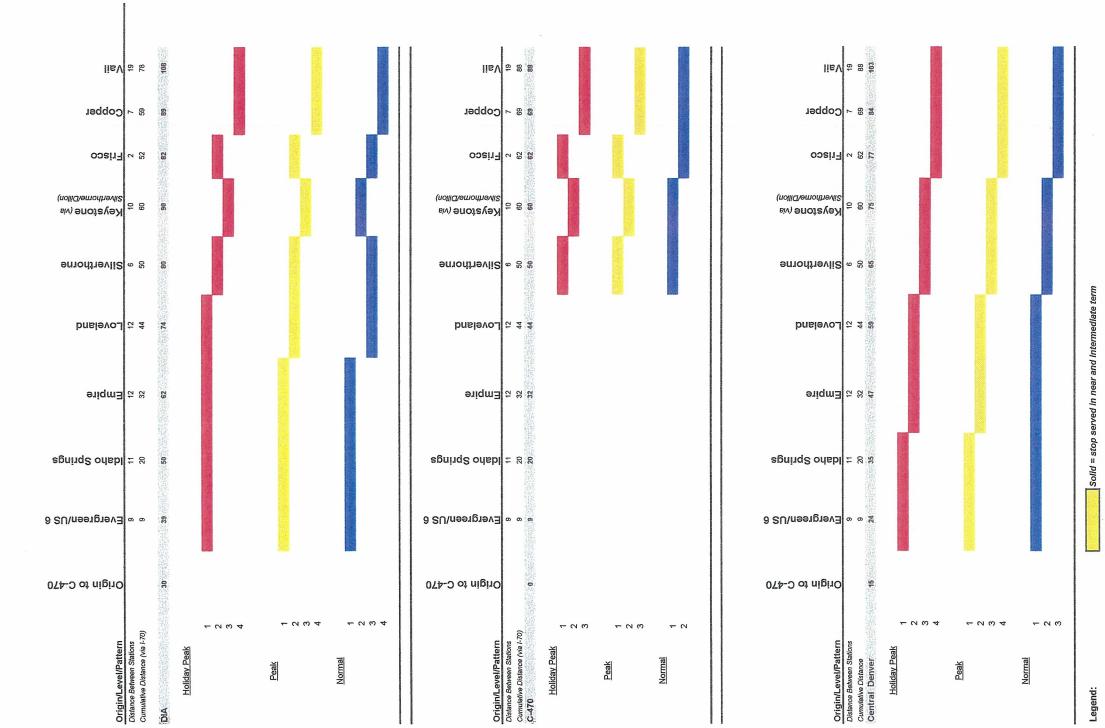






1 of 1

			Feed	H.			
Miles	Revenue Hrs I-70	Trolley	Total	Veh Hrs 20%	Speed	Miles	Total Miles
,864,066	270,380		270,380	324,456	20	6,489,120	18.353.186
.709,945	270,380		270,380	324,456	20	6,489,120	18,199,065
,709,945	270,380		270,380	324,456	20	6,489,120	18,199,065
677,334	270,380		270,380	324,456	20	6,489,120	18,166,454
677,334	270,380		270,380	324,456	20	6,489,120	18,166,454
214,639	270,380	132,915	403,295	483,954	28	13,666,533	22,881,172
214,639	270,380	132,915	403,295	483,954	28	13,666,533	22,881,172



RTT Travel Patterns

Stop served on a Demand Response basis

I I

Basic Fact

4/24/01 RTToperations2 Basic Pattern

g:200\01629\2ndScreen

1 of 2

Theoretical capacity of RTT modes

'eak period number of vehicles observed on I-70, per lane	ircent achievable with all buses, per lane	ak hour number of buses in dedicated lane	imber of seats: diesel buses (@45seats)
Peak	Perce	Peak	Numb

dual mode or electric buses (@ 60 seats)

rounded	Per 4/16/01 email from Scott Burger, J F Sato			24,000 Assumes that it is not feasible to put enough power in
	1075	50%	537.5	24187.5

in articulated diesel buses to reliably maintain speeds on I-70 grades with full loads 32,000 Assumes 60 foot articulated buses.

Basic Source: David Phillips, TSC-Chicago file: rail line 5.xls

2020 Rail Line Flows (peak	(day)						Boardings and Alig	phtings															
					Net on Board						Rieck chang	es:											
					WB flow,			Westbound Ra	ail Line	PH Offs	On-Board	Peak Hr	Peak Hr (PH)	PH Cumm		Ridership By C	•	Other Peak Ho	our Load	Eastbound	Rail Line	Total	
					peak hour										DIA	Central Den	C470	Average	Divided by 3				
Link	FROM_MP	TO_MP	FLOW	WB Flow		EB Flow	STOP	ON	OFF .	30%	cumm	30%	cumm (ons)	Ons	55%	15%	30%	20%	60%	ON	OFF	ON	OFF
DIA to Gateway	0.00	10.19	475	300	90	175	DIA	300	-		300	90	90	90				60	60	0	175	300	175
Gateway to Stapleton	10.19	18.26	1697	1,050	315	647	Gateway	752	3		1,050	315	315	405				210	210	4	476	756	479
Stapleton to Downing	18.26	21.96	4048	2,236	671	1,812	Stapleton	1,192	6		2,236	671	671	1,076				447	447	8	1174	1201	1180
Downing to DUT	21.96	23.89	4842	2,728	818	2,114	Downing	538	45		2,728	818	818	1,894				546	546	42	344	580	389
DUT to Wadsworth / I-76	23.89	32.31	24509	12,603	3,781	11,906	DUT	10,521	646		12,603	3,781	3,781	5,675				2,521	2,521	497	10289	11018	10935
Wadsworth to Golden	32.31	40.57	25550	13,216	3,965	12,334	Wadsworth	1,509	896	269	13.216	3,965	3,965	9,640		121		2,643	2,643	927	1355	2436	2251
Golden to Evergreen	40.57	49.98	27231	13,926	4,178	13,305	Golden	1,013	304	91	13,926	4,178	4,178	13,818		91		2,785	2,785	262	1232	1275	1536
Evergreen to US 6 / I-70	49.98	56.54	27170	13,896	4,169	13,274	Evergreen*	118	147	44	13,896	4,169	4,169	17,986	24	20		2,779	2,779	147	116	265	264
US 6 to Idaho Springs	56.54	61.69	27187	13,905	4,171	13,282	US 6*	10	2	1	13,905	4,171	4,171	22,158	0	0		2,781	2,781	2	11	13	12
Idaho Springs to Empire	61.69	69.66	26723	13,675	4,103	13,047	Idaho Springs	51	280	84	13,675	4,103	4,103	26,260	46	38		2,735	2,735	282	47	333	328
Empire to Loveland	69.66	85.80	26601	13,612	4,084	12,989	Empire*	18	81	24	13,612	4.084	4.084	30,344	13	11		2,722	2,722		21	97	102
Loveland to Keystone	85.80	95.43	25899	13,261	3,978	12,638	Loveland	121	472	142	13,261	3.978	3.978	34,322	78	64		2.652	2,652	471	120	592	592
Keystone to Silverthorne	95,43	102.94	23523	11,905	3,571	11.618	Keystone	260	1,616	485	11,905	3,571	3,571	37,894	267	73	145		2,381	1334	315	1594	1931
Silverthorne to Frisco	102.94	105.99	22278	11,276	3,383	11,003	Silverthorne	127	756	227	11,276	3,383	3.383	41,277	125	34	68		2,255	737	122	864	878
Frisco to Copper Mountain	105.99	113.28	18532	9,531	2,859	9,001	Frisco	320	2,065	620	9,531	2,859	2,859	44.136	341	93	186	,	1,906	2218	217	2538	2282
Copper Mountain to Vail	113.28	132.48	15963	8,193	2,458	7,770	Copper Mountain	109	1,446	434	8,193	2,458	2,458	46,594	239	65	130		1,639	1339	108	1448	1554
copper mountain to van	110.20	102.10	10000	0,100	2,100	1,110	Vail	-	8,193	2,458	(0)	(0)	(0)	46,593	1.352	369	737		(0)		0	7770	8193
							· cin		0,100	2,100	(0)	(0)	(0)	10,000	2,485	857	1.267		(0)	, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0	7770	0195
							*connectivity proble	m with hus service?	2						**See below left f								
							Totals	16.959	16.959	4 609	>>total throu	ah Golden			C470 distributio								
Per Bob Friis, Sato, Year 1 is	80-90% of th	is: therefore	we can ase	ume the sam	e ridershin for	the whole 50				-1,000	- cour anos	gnoonach				added to O en	Denver	62					
Per Friis, While some of the		· · · · · · · · · · · · · · · · · · ·							ange.							A 880	>>check	02					
Peak hour flow is based on 3			criver area i	3 1011, 110 011			io about right.	Offs								w,000 -	CHECK	1					
Peak nour now is based off 5	10 /0 Of all day i	lucionip						Golden to					"OFFS"										
								West	15,363				Capacity for Oth	or Dook hours									
	Origination	of Domone					Use	- West	15,565				Total Peak Day	el Peak nouis	15,363								
Bob Friis original work	Winter	Of Demand		0/	Total	0/	USE																
BOD FINS ORGINAL WORK	vvinter	70	Summer	%	Total	70		-					PH (highest)		4,609								
DIA/Out of State	20,706	65%	14,789	63%	35,495	64%	55%						Balance		10,754	DU (bistorio)	T () D						
	20,700	03%	14,709	03%	35,495	0470	00%						0/ for some inits	0 Deals Line	00%	PH (highest)	Total Peak						
Front Range	v 6.650		000		7 050					1:4			% for remaining	o reak mis	60%	30%	90%	D					
Resorts/Daily			606		7,256			0.170	Spl	lit	T . · · ·		Distant		0 (55								
Urban Areas/5 counties		050/	7,950		12,340	0001	150/	C470	Denver		Total		Riders		6,452								
	11,040	35%	8,556	37%	19,596	36%	45%	30.0%	15.0%		45.0%		Per Hour		2,151								
	04 7 10	40000	00.017	1000/		1000/	4000/	66.7%	33.3%		100.0%		Vehicles		47								
Grand Totals	31,746	100%	23,345	100%	55,091	100%	100%	-															

ip Not	Summan Daily Riders Daily Riders Daily Riders	50%		124,000		435,000	lenuur		63,000	127,000	222,000	Jenur	IA	43,000	86,000	150,000 270,000	1,500,000
This Ridership Not	Csed a n n Sily Riders	PH Share		4,969	2 320	5,329 1,640	siehy Riders] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	2,534	1,698	999	sisbiy Yiis	D	1,714	1,148	209	tiders
				33	2	ς, φ			27	1	ω			17	7	сл	Total RTT Riders
	Peak Vehicles			35 55 35	⊢∞ α	- ²³ 23 2	гелк Уећісіез	3	က်ယစ်	13 N N		ak Vehicles	ъч	∞ <i>−</i> ∩₹	0++>	÷ 0	Ĕ
	сџеск	2,485		2,484	1665	820	ileck	1,267	1,267	849	418	зеск	8 57	857	574	283	
	slstoT	2,484	2,484	162 466 267 1,590	1,665 56 364	1,066 820 28 88 88 779 525	- Totals	1,267	1,267 254 145 868	849 170 97 581	418 70 348	slato	т. 857	857 149 107 527	574 100 50 72 353	283 74 35 174	
	libV	1,352	1,352	1 352	906	906 446 445	lisv	737	737	494 494	243	līe	A 68	369	247 247	122	
	Copper	239	239	BE	160	160 79	Copper	130	130	87 87	6 4 64	obber	S C	8	44	21	
	Frisco	341	341	345	228 228	112	Frisco	186	186	125 125	61	risco	33 F	33 33	83 83	<u>ल</u> अ	
諸語に言語	¥enothevi≳ eiv)enoteγ (nollia	267	267	292	179 170	88	keystone(via indii0ten)		145	97 97	48 88	eystone (via Silverthorne) (noi)		73	49 49	24	
	Loveland бо del Destination finetthome fine	125	125	125	84 84	4	əmorthəvliS	89	88	46 46	52	əmorhəvli	S Pr	34	23 23	7	
	o S bnslevo B	78	78	4	52 52	26	bnslevol					bnslavo	64 L	64 64	43 43	31	mediate term basis
	Empire	13	13	10 10	ອ	4	Empire					eniqm	⊒ ⊭	740 States	~ ~	4	Solid = stop served in near and intermediate term Stop served on a Demand Response basis
	spring& odsbl	46	46	46	8 R	र ह	sgning2 odsbl					sgning2 orlsl	DI œ	38 38 38 38	52 52	12	= stop served served on a D
	8 SU\neergreen/US 6	24	24	24	16 16	ω 😅	8 SU\neergreen/US 6					vergreen/US 6	30 H	50	13 13	7	Solid
	074-⊃ of nigirO						0۲4-D of niginO					074-D of nigh	0 6	10 Contraction (1997)	9 9	30	
	Percent of PH Riders		100%		67%	%EE	Percent of PH Riders		100%	67%	33%	ercent of PH Riders	ď	100%	67%	33%	
RTT Travel Patterns 🦉	Origin/Level/Pattern	PH 2020 Offs (Westbound)	DIA Holiday Peak	r 0 € 4	3a ⊳ ⊐	Nomal 8 33 2: 4 0	Origin/Level/Pattern	PH 2020 Offs (Westbound)	G.470 Holidav Peak 3 3	<u>Peak</u> 3 3	Normal 2		PH 2020 Offs (Westbound)	Holiday Peak Holiday Peak 3 3	Peak P 33 0	Normal 3 2	Legend:
			Seating Capacity Seats 45								ľ						

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g:200\01629\2ndScreening

4/24/01 RTToperations2.xls Rider Distribution

1 of 1

Item			Assur	nptions	Op	erating	mair	tenance	Ope	+ maint	R	oiling Stock	Infrastructure	Commente
OTR Coaches Useful Life											s	350,000 12		
Stand Transit Coach iife											\$	275,000 12		
Dual Powered OTR Co	ach										\$	1.000.000		
life												12		
Trolleybuses (electric) Useful Life											ş	700,000 18		
Operations and Mainte Useful Life	nance Fac	llity											\$12,000,000 30	Enclosed structure, 30 to 40 vehicles
Bus Passenger Waiting (all climate controlled)	Facilities													
	Major Average Minor												4,000,000	Large Fully Staffed; fare media sales; 8-10 baya Medium Fully Staffed; fare media sales 5-6 baya Minimally staffed building 3-4 baya
Diesel Buses														
	Driver	Taxes	s	16.00 1.54										
		Ann OT		5%	\$	18.42								
		Yrly Benefits Per Hour	ş	6,000		2.88								
	Fuel		s	1.60										
		MPG MPH		4.5 35										
		Galls/Hour Fuel/hr		7.8		12.44								
	insurance/	mile Per Hour	s	0.05		1.75								
	20000	i ai ridui		1,2020										
	Dispatch	Taxes	s	18.00										
		Ann OT		5%										
		Yrly Benefits Per Hour	5	6,000		0.12								
	Other Supp					0.35								
	Mechanic		s	19.00										
		Taxes	\$	1.83										
		Ann OT Yrly Benefits	s	10% 6,400										
	And	nual Miles/Veh		60,000										
		Vehs/Mech Per Mile		4 0.032										
		Per Hour						1.12						
	Cleaners/F		s	10.00										
	1.343643669536	Taxes		0.97										
		Ann OT Yrty Benefits	s	10%										
	Ant	ual Miles/Veh		50,000										
		Vehs/Cleaner Per Mile		20 0.006										~
		Per Hour	8	257322				0.22						
	Parts/Mile	Per Hour	s	0.35				12.25						
	Tires/Mile	Per Hour	s	0.033				1.16						
	Deachead	Non												
	productive			33%	\$	12.01	Ş	4.93						
	Contingen	ΞY		9%		5.00		2.50						
Totals					s	52.98		22.18		75.16				

÷



Appendix A

Criteria and Assumptions for FGT/RTT Second Level Screening Process

	Criteria	Assumptions	Highest	Highest to Intermediate	Intermediate	Intermediate to Lowest	Lowest
	System Capacity	System capacity is based on conceptual ridership plans. The range is from an inability to provide seats for all passengers in peak direction during peak hours in opening year to an ability to provide seats for all peak hour passengers in peak direction forecast for year 20.	Significantly exceeds year 2020 demand	Somewhat exceeds year 2020 demand	Accommodates year 2020 demand.	Provides seats for opening year demand but not year 2020 demand.	Does not provide seats for all passengers in peak direction during peak hours in opening year demand.
	System Attractiveness	The relative attributes of the system technology to attract ridership based on the amenities and ride quality, including curvature, noise, food service, baggage handling, and susceptibility to weather conditions.	Vehicles in a guideway have higher ride quality, due to lower curvature, and quiet electric motors. Vehicles with food service, not as susceptible to weather conditions and full baggage handling.				Low ride quality is based on vehicles on the roadway in mixed traffic, greater curvature in the route, and high interior noise from power type and operations. Low amenities include vehicles with no food service, trip highly susceptible to weather and no baggage handling.
NEED	Average Speed	Average Speed in mph including stops/dwell for 10 stops - time based on Vail to C-470 or Golden trip times.	> 60 mph	50 to 60 mph	40 to 50 mph	36 to 40 mph	<35 mph
	Connectivity	Connectivity in number of transfers required between modes. The "ideal" is origin to destination with no transfer between transit vehicles at either of the Mountain Corridor journey.	Vehicles can operate through to destination at both ends of corridor, including wide variety of origins/destinations (I.e. sites in Metro Denver, Winter Park, Breckinridge, etc.)	Vehicles can interoperate on systems planned at either end of corridor. No transfer required at either end.	Vehicles can interoperate on systems planned at Denver end of corridor. No transfer required at I-470.	Vehicles can interoperate on planned Vail-Eagle system. No transfer required at Vail.	Vehicles cannot interoperate on systems planned at either end of corridor.Transfers required at both ends
	Feeder/Distributor Requirements	Feeder/Distributor Requirements in percent change in vehicle miles from that presently used for local transit services in the Corridor.	Feeder systems in existence or no feeder system needed. Minimal change in local transit services required in the corridor. Utilizes these existing feeder systems as their network.		Feeder systems in existence. Moderate change in local transit services required in the corridor.		New feeder systems required. Significant change in local transit services required in the corridor.
SAFETY	Safety System	System Safety - Measures relative safety of the transit alternative considering the relative potential for crashes.	Heavyweight (FRA compliant) rail vehicles on new alignment	Middleweight rail vehicles on new alignment	Use of buses with professional drivers only on guided transitway. Lightest weight rail vehicles on new alignment.	Use of buses with professional drivers only on transitway.	Mixed traffic, including vans (with lightweight construction).
	Infrastructure Cost	Including associated highway improvements over a 50 year period.	<\$10M/mile	\$10-20M/mile	\$20-30M/mile	\$30-40M/mile	>\$40M/mile
NOL	Technology Availability	Criteria range from technologies that are currently available to operate within the corridor to technologies that are currently in the developmental or research stage. The range in between covers any modifications required to existing technologies for operation in the corridor. An additional factor relates to the percent grade that given technologies are capable of operating within.	System is able to operate in the corridor without modifications.	Minor modifications required	Technology exists but requires significant modifications.	Extensive modifications required	System is in the research and development stage.
IMPLEMENTATION		Identifies whether linehaul mode uses petroleum-based fuel (with its currently available supply and established production and distribution system), or has a heavy use of electricity, (which is presently dependent on relatively limited production and generation capabilities and the potential difficulty/expense in providing needed additional capacity.)	Uses existing facilities	Uses existing facilities with some modifications	Uses some existing facilities and some new infrastructure	Uses mostly new infrastructure	Uses all new infrastructure.
	Fuel Limitations	Federal Policy dictates that transit systems minimize the use of non- renewable fuel sources. This criteria measure whether the proposed system is capable of using non-renewable fuels.	Uses multiple, renewable fuel resources	Uses renewable fuel resources,	Uses a combination of non- renewable and renewable fuel resources	Uses mostly non-renewable fuel resources,	Uses only non-renewable fuel resources (fossil fuels).
	Energy Consumption	Relative rating based on system power requirements. Diesel fuel is assumed at \$1.60/gal. Electrical energy is assumed at \$0.10/kWH.	<\$0.006/seat-mile	\$0.006/seat-mile	\$0.007seat-mile	\$0.008/seat-mile	>\$0.009/seat-mile

1	Assumptions							
	With the excention of the AGS alternatives only sve	teme with actual wo	vina evanalas	that are in recular of	the for one is			
1	Standard railroad gauge (4'8.5"/1435cm) examples were used, but other gauges could be utilized.	were used, but other	gauges could	be utilized.		ear, or more, are	Deing evalu	ated (see FGI Exa
	All systems assumed to be specified with air conditioning, reclining seats (and intercity seat pitch), rest rooms and, if desired, food service (except where noted).	oning, reclining seats	s (and intercity	seat pitch), rest room	is and, if desire	d, food service (e	except where	e noted).
T	All systems assumed to scheduled for no greater than seated loads (no standees).	an seated loads (no	standees).					
T	All are assumed to be self-propelled (with multiple unit operation) except those identified as Locomotive hauled.	nit operation) except	those identifie	d as Locomotive hau	led.	1.4		
	All electrically-powered trains are expected to be ope	erated on either low	voltage DC or	operated on either low voltage DC or high voltage AC systems.	ems.			
	All new FGT alignments, except light rail, will have no highway grade crossings except, possibly, in low speed areas.	lo highway grade cro	ssings except,	possibly, in low spee	d areas.			
		Typ. max. grades	Street legal	Street legal Limited train length	End doors	FRA compliant	Tilt avail.	Tilt avail. Double-deck avail
-		6%	yes	yes (3 cars/294")	ou	92	QU	
-	Diesel Light Rail Transit, double track	6%	yes	yes (3 cars/294")	QU	Q	ou	
-	Electric Light Rail Transit, single track	8%	yes	yes (3 cars/294')	9	00	OU	00
-	Electric Light Rail Transit, double track	8%	yes	yes (3 cars/294')	9	0	ou	2
-	Diesel Heavy Rail Transit, single track	6%	ou	DO	yes	9	ves	2
-	Diesel Heavy Rail Transit, double track	9%9	ou	DO	yes	ou	yes	00
-	Electric Heavy Rail Transit, single track	7%	ou	ou	yes	90	yes	yes
-	Electric Heavy Rail Transit, double track	7%	OU	ou	yes	ou	yes	yes
-	Diesel Loco. hauled Passenger KR, single track	4%	0	ou	yes	yes	yes	yes
-	Diesel Loco. nauled Passenger KK, double track	4%	0	Q	yes	yes	yes	yes
1	Electric Loco, fiduleu Fasseliger KK, single track	4%	2	90	yes	yes	yes	yes
-	Electric Locol riguieu Fasseriger KK, uouble track	4% £0/.	0	2	yes	yes	yes	yes
1	Flectric Multinle I Init Passenger RR, double track	C/0	0	0	yes	yes	ou	yes
-	AGS, Conventional Monorail, double guideway	10%	2 2	2	yes	yes	NA	
-	Electric CIFGA Monorail, double guideway	10%	ou	00	VAS	2 0	AN	01
-	Moffat Tunnel to Winter Pk. Diesel Loco. hauled Psg	2%	ou	6	Ves	ves	ves	Nex
-	Moffat Tunnel to Glenwood Diesel Loco. hauled Psg	2%	QU	QL	yes	yes	yes	yes
	Typ. max. grades	These are not the st routinely.	eepest grades	These are not the steepest grades that can be climbed by a given technology but, rather, the steepest that are used fairly outinely.	oy a given techi	nology but, rather	r, the steepe	st that are used fair
	Street legal	Light rail trains can r	not only cross :	Light rail trains can not only cross streets at grade but. Where appropriate run on streets intermived with vehicle treffic	where appropria	te run on streets	c intermixed	with vahicle traffic
	Limited train length	Light rail train length is limit intersections while stopped.	is limited by th topped.	Light rail train length is limited by the need to keep passenger stops within the length of a city block to avoid blocking intersections while stopped.	enger stops wit	hin the length of a	a city block	to avoid blocking
	End doors	Doors between cars available seats. The facilitate food servici	of a train are f y are required e, allowing a si	Doors between cars of a train are feature of all rail modes except light rail. These allow passengers to readily move to cars with available seats. They are required for systems with on-board fare collection (unless each car has a collector). They also facilitate food service, allowing a single dining car to serve patrons on an entire train.	es except light r oard fare collective batrons on a	ail. These allow p tion (unless each in entire train	bassengers t	to readily move to c collector). They also
	FRA compliant t	Identifies modes which are built to the Federal be met for operation on the national rail syster cannot normally be operated on light rail lines.	ch are built to on the nationa perated on lig	Identifies modes which are built to the Federal Railroad Administration's standards for buff strength ,etc. FRA standards must be met for operation on the national rail system. Because of their high buff strength characteristics, FRA-compliant equipment cannot normally be operated on light rail lines.	Administration's e of their high t	s standards for bu buff strength chan	uff strength , acteristics, R	etc. FRA standards -RA-compliant equi
100	Tilt avail.	Identifies modes for	which trains wi	Identifies modes for which trains with tilting hody seasehility (which allows factor sector sector and sector	mollo doidul uti	- forther and and	1	
ł				In third your caugali	IN WINCH AND	International and the second states and second valuation (which allows laster operation)	ID UDIOJUL	Turn need sed toev

	Mode Diesel Light Rail Transit Electric Light Rail Transit Diesel Heavy Rail Transit	Examples	
	I Light Rail Transit ic Light Rail Transit is Heavy Rail Transit	Examples	
	l Light Rail Transit ic Light Rail Transit il Heavy Rail Transit		Adaptations assumed for tested example
	ic Light Rail Transit I Heavy Rail Transit	NJ Transit (Camden-Trenton), OC Transpo (Ottawa), several in Europe	Intercity seating, rest rooms, no food service
	l Heavy Rail Transit	RTD and multiple other U.S. systems. Karlsruhe (Germany) pioneered multi-voltage LRT and has food service for its longer	Intercity seating, rest rooms, no food service
		Non-FRA compliant Diesel Multiple Unit (DMU) trains in various countries (including British, French, German and Australian). (Tilting DMUs have been built for German Federal Railways, Virgin Rail, Britain and Norwegian Railways)	All tested examples have tilting capability. Magnetic track brakes assumed for 6% grade alignment
T	Electric Heavy Rail Transit	Non-FRA compliant Electric Multiple Unit (EMU) trains. EMUs built for railways throughout the world by multiple suppliers, including those built for mountain railroads, fall into this category. (Tilting EMU trains are operated in Italy Switzerland and Finland. Double Deck EMU trains are operated, including in France and Australia.)	All tested examples either have titting capability or are double deck (combination is not available). Magnetic track brakes assumed for 6% grade alignment
9, 10 Diesel	Diesel Loco. hauled Passenger RR	FRA-compliant trains such as Amtrak Amfleet, Horizon and NY State Turbotrains, as well as some commuter rail operations. (Double deck examples include Amtrak Superfinens California cars and Pacific Surfliners as well as numerous commuter systems. Tilting examples include Amtrak Cascade Talgo trains.)	All tested examples either have titting capability or are double deck (combination is not available). Locomotives on both ends for added power & dynamic braking.
11, 12 Electri	Electric Loco. hauled Passenger RR	RFA-compliant trains such as Amtrak Acela and Amfleet, as well as SEPTA and Manyland DOT commuter rail operations. (Double-deck examples include Manyland DOT and Long Island RR.)	All tested examples either have titting capability or are double deck (combination is not available). Locomotives on both ends for added power & regenerative braking, magnetic track brakes assumed for 6% grade alignment
13, 14 Electri	Electric Multiple Unit Passenger RR	FR4-compliant EMU trains, as used by SEPTA, NJ Transit, Long Island RR, Metro North and South Shore. (Only FRA-compliant double deck example is Metra Electric-Chicago suburban.)	Both single and double deck examples are tested. Tilting capability not available. Magnetic track brakes assumed for 6% grade alignment
15 AGS,	AGS, Conventional Monorail	The most common type of AGS is the supported monorail; they are operated in transit service (non-amusement park) in a variety of locations around the world. Suspended monorails are operating in Japan (Shonan and Chiba City)and Germany (Wuppertal and Dortmund University). No side-hanging systems have been built, although a major effort, including construction of a test track, is underway in South Carolina.	Intercity seating, rest rooms, no food service
16 Electri	Electric CIFGA Monorail	No systems have been built, to date; concept planning only.	Intercity seation
	Moffat Tunnel to Winter Pk. Diesel Loco. hauled Psgr RR	Loco. hauled Psgr RR see 9	Same as 9
18 Moffat	Moffat Tunnel to Glenwood Diesel Loco. hauled Psgr RR		Same as 9
Suppliers			
others she	There has been a continuing, worldwide consolids ranne. Others specialize in only one or two areas	There has been a continuing, worldwide consolidation of suppliers in the railcar manufacturing industry. With this consolidation, some provide products over the complete range. Others specialize in only one or two areas	ne provide products over the complete

All Si All Fi Al	RTT	Assumptions	
All systems assumed to schedules of carriers Use of Transitways will be limited to vehicles of carriers Peak direction-only alternatives utilize normal I-70 alignme Paus and Improved Van in mixed traffic No Bus and Improved Van in mixed traffic No Bus and Improved Van in mixed traffic No Bus and Improved Van in mixed traffic No Diesel Bus in marked HOV lane, poth Addition Diesel Bus in separated HOV Lanes, peak Addition Diesel Bus in separate transitway, peak Addition Diesel Bus in separate transitway, peak Addition Diesel Bus in separate transitway, both Addition Diesel Bus in guided transitway, both		All systems assumed to be specified with air conditionir	 reclining seats and rest rooms. eated loads (no standees).
Use of Itaniaryoy atternatives utilize normal 1-70 alignmet All RTT systems will be tested on existing 1-70 alignmet Bus and Improved Van in mixed traffic Mr Bus and Improved Van in mixed traffic Mr Bus and Improved Van in mixed traffic Mr Bus and Improved Van in mixed HOV lane, both Ar Diesel Bus in marked HOV lane, both Ar Diesel Bus in separated HOV Lanes, peak Ar Diesel Bus in separate transitway, peak Ar Diesel Bus in separate transitway, both Ar Diesel Bus in separate transitway, both Ar Diesel Bus in guided transitway, both Ar Dial Mode Bus in		All systems assumed to scheduled to vehicles of carriers	specifically certified for this operation, or assumed to be uncongested.
AIRTT systems will be tested on existing 1-70 angume AIRTT systems will be tested on existing 1-70 angume Diesel Bus in marked HOV lane, both Ar Diesel Bus in marked HOV lane, both Ar Diesel Bus in separated HOV lane, both Ar Diesel Bus in separated HOV Lanes, peak Ar Diesel Bus in separate transitway, peak Ar Diesel Bus in separate transitway, both Ar Diesel Bus in separate transitway, both Ar Diesel Bus in guided transitway, both Ar Dual Mode Bus in guided		Use of Iratisitways must be utilize normal I-70 lane	tor reverse-peak more more than the second
Bus and Improved Van in mixed traffic No Diesel Bus in marked HOV lane, peak A Diesel Bus in marked HOV lane, both A Diesel Bus in marked HOV lane, both A Diesel Bus in marked HOV lane, both A Diesel Bus in separate transitway, peak A Diesel Bus in separate transitway, both A Diesel Bus in separate transitway, both A Diesel Bus in separate transitway, both A Diesel Bus in guided transitway, both A Dual Mode Bus in guided transitway, both		All RTT systems will be tested on existing I-/U alignine	I I I I I I I I I I I I I I I I I I I
Bus and Improved Vanimized and Improved Vanimized HOV lane, both Ar Diesel Bus in marked HOV lane, both Ar Diesel Bus in separated HOV lane, both Ar Diesel Bus in separated HOV lane, both Ar Diesel Bus in separated HOV Lanes, peak Ar Diesel Bus in separate transitway, peak Ar Diesel Bus in separate transitway, both Ar Diesel Bus in separate transitway, both Ar Diesel Bus in guided transitway, both Ar Dual Mode Bus in separate transitway, both Dransitway, peak Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in gu	1	NC Not traffic	Te
Diesel Bus in marked HOV lane, both A Diesel Bus in separated HOV Lanes, peak A Diesel Bus in separate transitway, peak A Diesel Bus in separate transitway, both A Diesel Bus in separate transitway, both A Diesel Bus in separate transitway, both A Diesel Bus in guided transitway, both A Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Diate transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both	- 0	1000	HOV lane (with shouldels) would be limited to buses, vans and automobiles with 3 or more riders. Dess would be limited to buses, vans and automobiles with activity as a widening of each side of 1-70. Access would be limited to buses, vans and automobiles with
Diesel Bus in separated HOV Lanes, peak A Diesel Bus in separate transitway, peak A Diesel Bus in separate transitway, both A Diesel Bus in separate transitway, both A Diesel Bus in guided transitway, peak A Diesel Bus in guided transitway, both A Diesel Bus in guided transitway, both B Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, both 11 Dual Mode Bus in guided transitway, both 12 Dual Mode Bus in guided transitway, both 13 Dual Mode Bus in guided transitway, both 14 Dual Mode Bus in guided transitway, both 15 Electric Bus in guided transitway, both 15 Electric Bus in guided transitway, both 16 Electric Bus in guided transitway, both			HOV lane (with shoulders) would be operated as a one more readway, either integrated with I-70 or parallel. It would be operated as a one more riders.
Diesel Bus in separate transitway, peak A Diesel Bus in separate transitway, both a Diesel Bus in guided transitway, both a Diesel Bus in guided transitway, both b Diesel Bus in guided transitway, both c Dual Mode Bus in separate transitway, both c Dual Mode Bus in guided transitway, both c Electric Bus in guided t	4	peak	Jouble HOV lane (with shoulders) would be during a direction only, with reverse-flow operation in one direction. Linux of the peak direction only, with reverse-flow operation in one direction. Linux of the peak direction only, with reverse-flow operation in one direction. Linux of one direction two lane roadway, operated in the peak, vans and automobiles with 3 or more riders. Access would be limited to buses, vans and automobiles with 1-70 or parallel. It would be operated as a one list at all "station" sites. Access would be limited to buses, vans would be the rider redway, either integrated with 1-70 or parallel. It would be operated by the bu
Diesel Bus in separate transitway, both d Diesel Bus in separate transitway, both a Diesel Bus in guided transitway, both d Dual Mode Bus in separate transitway, peak d Dual Mode Bus in separate transitway, both d Dual Mode Bus in guided transitway, both d Electric Bus			single lane (with shoulders) would be built as a separate received for operation in regular I-70 lanes. Entrance and contracted as a supervision only, with reverse-flow operation in regular I-70 lanes.
Diesel Bus in separate transitway, both 0 Diesel Bus in guided transitway, peak 1 Diesel Bus in guided transitway, both 1 Diesel Bus in guided transitway, both 1 Diesel Bus in guided transitway, BRT stations 1 Dual Mode Bus in separate transitway, peak 1 Dual Mode Bus in separate transitway, both 1 Dual Mode Bus in guided transitway, both 1 Electric Bus in separate transitway, both 1 Electric Bus in guided transitway, both 1	2		ection roadway, operated in the peak uncounted with the peak uncounter of the peak and pre-authorized vans (driven by CUL more a). all "station" sites. Access would be limited to buses and pre-authorized vans, either integrated with I-70 or parallel. It would be operated as a bi-
Diesel Bus in guided transitway, peak Diesel Bus in guided transitway, both Diesel Bus in guided transitway, both Diesel Bus in guided transitway, BRT stations Dual Mode Bus in separate transitway, peak Dual Mode Bus in separate transitway, both Dual Mode Bus in separate transitway, both Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, both Electric Bus in guided transitway, both	9		rectional roadway. No passing would be permitted. Entrance and exit tamps more and exit tamps more and the sectional roadway. No passing would be permitted to the section of the section
Diesel Bus in guided transitway, both Diesel Bus in guided transitway, BRT stations Dual Mode Bus in separate transitway, peak Dual Mode Bus in separate transitway, both Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, BRT stations	-		single lane would be overaged as a one direction roadway, operated in the peak whould be limited to buses equipped for the guideway in 1-70 or parallel. It would be operated as a one direction roadway, operated in the Access would be limited to buses equipped for the guideway of lanes. Dedicated entrance and exit ramps would be built at all "station" sites. Access would be limited to buses equipped for the guideway of lanes. Dedicated entrance and exit ramps would be built at all "station" sites. Access would be limited to buses equipped for the guideway of lanes. Dedicated entrance and exit ramps would be built at all "station" sites. Access would be limited to buses equipped for the guideway equipped is the integrated with 1-70 or parallel. They would be operated bi-
Diesel Bus in guided transitway, BRT stations Dual Mode Bus in separate transitway, peak Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, both Electric Bus in guided transitway, both Electric Bus in guided transitway, both	ŝ	Diesel Bus in guided transitway, both	we guideway lanes would be built at all "station" sites. Access would be would be built at all "station" sites. Access would be merence and exit ramps would be built at all "station" sites. Access would be merence and exit ramps would be built at all "station" sites.
Diesel Bus in guided transitway, BRT stations Dual Mode Bus in separate transitway, peak Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, beth Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in separate transitway, both Electric Bus in separate transitway, both			echnology. echnology. Bedicated be built as a separate roadway equipped, either integrated with I-ru or parameter and exit ramps would
Dual Mode Bus in separate transitway, peak Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, peak Dual Mode Bus in guided transitway, both Electric Bus in guided transitway, both	0	Diesel Bus in guided transitway, BRT stations	directionally. On-line stations would be built at all "stations". Passing is portioned at the guideway technology. Sirectionally On-line station" sites. Access would be limited to buses equipped for the guideway technology.
Dual Mode Bus in separate transitway, both Dual Mode Bus in guided transitway, peak Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, both	*		Same as 5, except transitively and rainips would be a normal buse
Dual Mode Bus in separate transitway, bound Dual Mode Bus in guided transitway, peak Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, both Electric Bus in separate transitway, both Electric Bus in guided transitway, both	-		Same as 6, except transitway and ramps would be equipped with overhead Parts and the standard of an indeway.
Dual Mode Bus in guided transitway, peak Dual Mode Bus in guided transitway, both Dual Mode Bus in guided transitway, BRT stations Electric Bus in separate transitway, both Electric Bus in guided transitway, both	120		wire by a could operated as normal buses off wire. wire as 7 except transitiway and ramps would be equipped with power rails for buses. Buses could operate normally off guideway.
Dual Mode Bus in guided transitway, over Dual Mode Bus in guided transitway, BRT stations Electric Bus in separate transitway, both Electric Bus in guided transitway, both	1		Same as 8, except transitivay and ramps would be equipped with power rails for buses. Buses could operate normally on guideway.
Dual Mode Bus in guided transitivery, by both Electric Bus in separate transitivery, both Electric Bus in guided transitivery, both	1		Same as 9, except transitivay and ramps would be equipment of the equipment provided by the equipment of the
Electric Bus in separate reneway. Electric Bus in guided transitivary, both	1		Same as 6, except transmust and ramps would be equipped with power rails for buses. Buses carnot other and a diversely and the equipped with power rails for buses.
Electric Bus in guided it answer, both stations	12		Same as 8, except transmay run remove memory and be equipped with power rails for buses, buses cannot be accepted with power rails for buses.
	11		Same as 9, except transitively and rampy more and a second s

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F	RTT Examples		
	Mode	Examples	Adaptations assumed for tested example
-	Bus and Improved Van in mixed traffic	Marin Co., CA, Los Angeles, Seattle have BRT stations on freeways	None
2	Diesel Bus in marked HOV lane, peak	I-25, U.S. 36 (Boulder Tpke), New Jersey (XBL)	no BRT stations
3	Diesel Bus in marked HOV lane, both	Los Angeles (I-605-Harbor Freeway, includes BRT stations)	no BRT stations
4	Diesel Bus in separated HOV Lanes, peak	Washington D.C. (Shirley Highway)	
2	Diesel Bus in separate transitway, peak	Houston	
9	Diesel Bus in separate transitway, both	Pittsburgh, Ottawa, Curitiba (Brazil), (all have BRT stations)	no BRT stations
1	Diesel Bus in guided transitway, peak	none	
8	Diesel Bus in guided transitway, both	Adelaide, Australia	
6	Diesel Bus in guided transitway, BRT stations	Las Vegas (proposed)(slow speed)	Technology used in Las Vegas apparently limited to 70kph (42mph); Adelaide technology assumed
10	Dual Mode Bus in separate transitway, peak	none	
7	Dual Mode Bus in separate transitway, both	Seattle, Silver line, Boston (under construction)(both include downtown tunnels with BRT stations)	no BRT stations
12	Dual Mode Bus in guided transitway, peak	none	
13	Dual Mode Bus in guided transitway, both	none	
14	Dual Mode Bus in guided transitway, BRT stations	Caen, Lyon, Grenoble, Rouen (all in France, slow speed)	Technology used in France apparently limited to 70kph (42mph); Adelaide technology assumed
15	Electric Bus in separate transitway, both	Euclid Blvd., Cleveland (system in design, slow speed system, includes BRT stations)	high speed electric buses not proven; assumes they are feasible
16	Electric Bus in guided transitway, both	none	
17	Flectric Bus in guided transitway. BRT stations	Essen, Germany (slow speed, discontinued)	



Appendix B

Types of FGT Equipment Tested

I-70 PEIS																		
Rail Equipment Analysis																		
Diesel LRT																		
•						Aux power						Max						
Cars tested (from Railsim 7® Rolling Stock library)	Stock library)				Continuous			Max				Train	Floor					
Type	Length	Wt Lbs	Wt Tons	Axles	Power	engine	Aux kW	Speed	Max Accel.	Max Accel. Max Decel. Capacity	Capacity	Length	level			Comments		
AEG RegioLiner DMU (LTG 260)	134	102,734	51.4	9	737HP	~	40kW		<u> </u>	2.17MPH/s 3.07MPH/s	117	4	=					
Siemens-Duewag 628.4 Light Diesel	151.8	154,880	77.4	8	650HP	z		75MPH	2.5MPH/S	3.0MPH/s	148	4	1					
NJT 2000-2001 SNJ Concept Art	95	107,000	53.5	9	600HP	×	40KW	60MPH			80	4	=					
Siemens Regio Sprinter VT4N	81.5	66,138	33.1	4	530HP	٢	40KW	60MPH	60MPH 2.96MPH/s 6.5MPH/s	6.5MPH/s	74	4	-			Ī		
Trains tested Type AFG Reviol Invertigation	No. of cars	Train Length (ft.)	Modi Car Capac.	Modifications assumed ar Train ac. Capac. Other	ssumed		Comments			beeds E	Highwent Binwent Binwent Binwent Binwent Binwent Highwent	pesn lenj či suolisoj	Speed 69		pesn jenj Sellous	.8vA beeq2	4% alignment	pesn jenj suojieg
Siemens-Dueward 628 4 Light Diecel		607	118	477							staned			stalled		insui	insufficient braking	Bui
IN IT DOUG THE FORD AND THE PARTY AND THE PA		000	011	2000						30.0	2.22	224		stalled		40.1	2:16	212
Simmer Basic Sectors Man	+ •	000	g s	007						41.7	2:04	178	41.5	2:05	180	44.8	2:02	160
Sterinens Regio Sprinter VI4N	4	320	60	236						46.1	1:52	131.6	45.8	1:53	133	48.7	1.52	120.2

FGT equipment tested Dies. LRT 1 of 6

I-70 PEIS																-	
Rail Equipment Analysis																T	
Electric LRT																	
Cars tested (from Railsim 7® Rolling Stock library)	ock librar	() ()														1	
											Max					1	
Type	Length	Wt Lbs	Wt Tons	Axles	Continuous Power	Aux kW	Max Speed	Max Accel	Max Accel Max Decel Capacity	Capacity	Train	Current	Floor	Comments	ste		
Denver RTD 1998-99 Siemens-Duewag	7.67	88,660	44.3	9	813	40	55	3.0MPH/s	3.5MPH/s	64	-	750Vdc	-			t	
Boston MBTA 1998-2001 Breda #8 LRV	74	86,000		9	520	40	55	2.8MPH/s	-	46		620Vdc					
Buffalo NFTA 1984-85 Tokyu Car LRV	66.8	66,000		4	540	40	55	3.0MPH/s	3.5MPH/s	51	4		Ħ	Non-Articulated	bulated	t	
Dallas DART 2000-01 Kinki-Sharyo/Itochu	92.6	107,000	53.5	9	750	40	85	3.5MPH/s	1	76	4	750Vdc	=			1	
NJ Transit Newark/HBLRT Kinki-Sharyo/Alstom	89.6	155,99	49.7	9	643	40	55	3.5MPH/s	4.5MPH/s	72	4	750Vdc	H			1	
Portland Tri-Met 1997-9 Type 2/SD Low Floor	91.9	109,000		9	752	40	55	3.5MPH/s	6.0MPH/s	72	4	650Vdc	Ш			t	
Sacramento SRTD 2001-03 High Floor LRV		77,162	38.6	9	507	40	55	2.9MPH/s	6.5MPH/s	64	4	750Vdc	H				
San Jose Santa Clara VTA 200 Low Floor LRV		100,000	50	9	1050	40	55	3.5MPH/s	5.0MPH/s	68	3	750Vdc	H			-	
Karlsruhe VBK 1994-95 GT8-100C/S2	123	129,189	61.5	80	657	40	62	2.5MPH/s	4.1MPH/s	101	4	15000ar	I	dual with	dual voltage(also 15000Vdc)	15000V/d	10
												Test results I-470 - Vall	ts I-470 -	Vail			
I rains tested			Modifi	Modifications assumed	assumed				High	Highway alignment	nent	6%	6% alignment	ŧ	4%	4% alignment	Ŧ
		Train								p			p				í
	No. of	Length	Car	Train					eed B	əu əsdi	pə 4	pəə 'ß	əu əsdi	pe 4	bsd pea fi	(u ət	pe 4
Type	cars	(tr.)	Capac.	Capac.	Other				٧A	비크	sn M)	ds ^y	el3	esr M)		im	M
Denver RTD 1998-99 Siemens-Duewag	4	319	51	204					47.5	1:49	2379	47.3	1:49	2414		1-50	5173
Boston MBTA 1998-2001 Breda #8 LRV	m	222	37	111					42.7	2:01	1695	42.5	2:02	1708	-	2-01	1536
Buffalo NFTA 1984-85 Tokyu Car LRV	4	268	41	164					46.1	1:52		45.9	1:53		+	1:53	
Dallas DART 2000-01 Kinki-Sharyo/Itochu	4	370	61	244					47.2	1:50	2877	46.9	1:51	2910	50.2	1-49	2636
NJ Transit Newark/HBLRT Kinki-Sharyo/Alstom	4	358	58	232					43.6	1:59	2528	9:36	2:00	2557	47.7	1:54	2250
Portiand Tri-Met 1997-9 Type 2/SD Low Floor	4	368	58	232					44.7	1:56	2742	44.5	1:57	2774	46.9	1-56	2479
Sacramento SRTD 2001-03 High Floor LRV		319	51	204					40.7	2:08	2058	40.3	2:09	2083	42.3	2:09	1873
San Jose Santa Clara VTA 200 Low Floor LRV		266	55	165					48.6	1:47	2003	48.4	1:47	2028	49.9	1:49	1823
Karlsruhe VBK 1994-95 GT8-100C/S2	4	492	86	392					40.8	2.07	FRCF	20.6	2.08	3303	CVV	2.02	0200

I-70 PEIS																	
Rail Equipment Analysis																	
Diesel Heavy Rail Transit (HRT)																	
											â						
Cars tested (from Railsim 7® Rolling Stock library)	rary)																
Туре	Length	Length Wt Lbs	Wt Tons	Axles	Continuous Power	Aux power from engine	Aux power from engine Aux kW	Max Speed	Max Accel	Max Decel	Capacity	Max Train Lenoth	Floor	Comments			
Melbourne Metropolitan Transit Comeng MU	78.8	97,827	48.9	4	432HP	z		71.8MPH	71.8MPH 2.74MPH/s	2.74MPH/s	97	1	H				
RENFE Spanish 1999 Talgo 1668 DMU-12	49	53,278	26.5	1.25	335HP/u			136MPH	1.45MPH/s		396	12					
BR British 1992 ABB 166TT DMU-3 Turbo	73.2	86,532	43.3	4	349HP/u			89.5MPH	89.5MPH 2.2MPH/s I	.89MPH/s ir	274	12					
ABB Explorer/Endeavour DMU-3	79.6	128,590	64.3	4	473HP			90.6MPH	2.5MPH/s1	-		12					
Hong Cong MTRC 1981-95 Aistom RT	80	97386	48.7	4	1273HP	z	40	84MPH	2.74MPH/s	2.96MPH/s	100	12					
Trains tested			Modifi	Modifications assumed	ssumed					High	Highway alignment	nent	Test re	Test results I-470 - Vail 6% alignment	_	4% alianment	
Type	No. of cars	Train Length (ft.)	Car Capac.	Train Capac. Other	Other	25	Comments	ţ		pəədə 7AB'	esqsli 9miT i (nim	pəsi Jən Sallons	pəəd voð	iapse Time (nim (nim (nim (nim (nim (nim (nim))(nim))(ni	beed 'AB' pes	əsqsi əmiT (nim	pəs jər suojje
Melbourne Metropolitan Transit Comeng MU	12				_						not tested	5	S Ø	ų D		Incretional Braham	n 11 12
RENFE Spanish 1999 Talgo 1668 DMU-12	12	588	33	396							not tested			not locied		NISUINCIN .	COMPIC
		0		0											LAILED	oralieu un grade	ane
				0													
BR British 1992 ABB 166TT DMU-3 Turbo	12		878.4 219 (3)	876							not tested			not tested	33.2	2:44	424
ABB Explorer/Endeavour DMU-3	12		130 (3)			With FS	With FS Cap is 497	2			not tested				36.4		471
Hong Cong MLKC 1981-95 Alstom K1	12	096	48	576							not tested			not tested	FAILED	Stalle	

I-70 PEIS																		
Rail Equipment Analysis																	T	
Electric Heavy Rail Transit (HRT)																		
Cars tested (from Railsim 7® Rolling Stock library)																		
					Continuous	1.00	Max			Cars in	Car	Set		Floor			-	
Type	Lengt	Length Wt Lbs Wt Tons	Wt Ton:	s Axles	Power	Aux kW	V Speed	Max Accel.	Max Decel.	set	ů	ပိ	Current		Ħ	8	Comments	
Healthrow Exp Class 332 EMU	67.2	-	37.6	4	402/u		HdW66	2.24MPH/s	1.0MPH/s	4	62	248		Ξ				
DB AG German 1999 Class 426 EMU	55.4	59,525	29.8	4	250/u	20	62MPH		1 1.0MPH/s sr	2	20	100	1500Vdc	1			1	
Paris RER 1996 Alstom/ANF MI 2N BiLevel EMU-5	73.5	126,985	63.5	4	965	89	86.9MPH	86.9MPH 2.96MPH/s		2	8		25000Var	H		>		
Paris SNCF Z20500 BiLevel EMU-4												1				-		
Modified Pendolino EMU																		
Example EMU r2																		
Trains tested			Modi	Modifications	assumed	_					High	Highway alignment		st results 6%	Test results I-470 - Vail 6% alignment		4% alignment	ment
env)	No. of	No. of Length	Carac	Train	Other						beed vg.	əmi bəsqa	pəsn yw	pəəd Bv	əm bəsqə	pəsn yv	ətə pəsdə pəəc '6/	pesn yv
			inning	(and no	in the second			3			s V		N	S V		8	II IS	
Heathrow Exp Class 332 EMU	12	806	ľ									not tacted		EALL CD	EAH ED Jaard Darling		TAL PA	
DB AG German 1999 Class 426 EMU	12	665	40	480								not tested		FAILED	FAILED IIISUI DIGNES		24 A 2-38 5370	LI DI BI
Paris RER 1996 Alstom/ANF MI 2N BiLevel EMU-5	10	735		0								not tested			Not Tested		AILED SH	EAll ED Stalled on grade
Paris SNCF Z20500 Billevel EMU-4	80			0								not tested			Not Tested		AILED Sta	FAILED Stalled on grade
Modified Pendolino EMU	9											not tested			Not Tested		All FD Sta	FAILED Stalled on orade
Example EMU r2												not tested		44.5	1:56	CVS	47.4 4.56	6240

Multiyes Multipasenger RR In In<	I-70 PEIS																		
Unit Passenger RR Image: Contrinuous light with the second light with with the second light with the second light with with the second l	Rail Equipment Analysis																		
Note: Tele Tele Max Max Max Max Tele	Electric Multiple Unit Passenger RR																		25
Max Train Floor F	Care tracted //rom Dollars 7@ Dolling Clark like	1																	
Type Max Max Max Max Train Floor Floor <td>Cars resten (non cansin tes contrist soco inte</td> <td>(Kip)</td> <td></td>	Cars resten (non cansin tes contrist soco inte	(Kip)																	
Type Length Wt Lbs WT Toris Artes Power Aux KW Speed Max Accel Max Decel Canotic Length Current Level Comments dier/Alsion-Acella Cars 83 123,571 61.3 4 857.9 15 3MPHs 2559 8 25000/ac HL Lu 95 Class MR90 85.3 113,000 55.5 4 790 25.3MPHs 3.0MPHs 3.000/ac HL LL L L L L 259 8 25000/ac HL LL L						Continuous		Max				Max Train		Floor					
dier/Alsionn Acela 6 Cars 83 122,571 613 4 857,9 160 2.5MPHIs 259 8 25000Vac HL LL Shore 2000-1 EMU-1 85 113,000 59.5 4 79 1,5MHHs 110 8 1500Vac HL 8.1L Shore 2000-1 EMU-1 85 138,280 59.1 4 79 1,5MHHs 110 8 1500Vac HL 8.1L Arrow III 85 138,280 59.1 4 1340 30 100 2.3MPHIs 18 1 8 1500Vac HL 8.1L Arrow III 85 138,280 59.1 4 1340 30 100 2.5MPHIs 119 14 2500Vac HL 8.1L Arrow III 85 138,280 59.1 4 1340 30 100 10 2.5MPHIs 119 14 2500Vac HL 11 1 2.500Vac HL 11 1 2.500Va	Type	-		Wt Tons	and in	Power	Aux kW	Speed	Max Accel.	Max Decel.	Capacity		Current	Level	Comments				
Shore 2000-1 EMU-1 85 119,000 56.5 4 600 79 136,MPHs 110 8 1500Vdc H.& Li L 1 95 Glass MR90 85.3 113,000 56.5 4 760 62.5 68 2.0MPHs 88 8 25000Vac H.& Li L 1 95 Glass MR90 85.3 113,000 56.5 4 760 62.5 68 2.0MPHs 88 8 25000Vac H.& Li L 1 Arrow III 85 138,280 69.1 4 1340 80 100 2.5MPHs 119 14 25000Vac H. 1 Arrow III 85 138,280 69.1 6 100 2.3MPHs 119 14 25000Vac H. 1 <td>Amtrak 1999 Bombardier/Alstom Acela 6 Cars</td> <td></td> <td>122,571</td> <td>61.3</td> <td>4</td> <td>857.9</td> <td></td> <td>160</td> <td>2.5MPH/s</td> <td>2.75MPH/s</td> <td>259</td> <td></td> <td>25000Vac</td> <td>HI & II</td> <td></td> <td></td> <td></td> <td></td> <td></td>	Amtrak 1999 Bombardier/Alstom Acela 6 Cars		122,571	61.3	4	857.9		160	2.5MPH/s	2.75MPH/s	259		25000Vac	HI & II					
85 Class MR90 85.3 113,000 56.5 4 760 62.5 68 2.0MPHIs 3.0MPHIs 88 8 25000Vac HL & LL h L L h L L 1 130.0 136.5 1 4 1340 30 100 2.3MPHIs 119 14 25000Vac HL & LL h L L L L L L L L L L L L L L L L	NICTD Indiana South Shore 2000-1 EMU-1	85	119,000	59.5	4	600		62	1.95MPH/s	2.5MPH/s	110	80	1500Vdc	HL & LL					
Arrow III B5 138,280 69.1 4 1340 80 100 2.3MPHIs 119 14 25000Vac HL & LL I	Montreal AMT 1994-95 Class MR90	85.3	113,000	56.5	4	760	62.5	68	2.0MPH/s	3.0MPH/s	88	80	25000Vac	HL & LL					
No. of Latin Train Train Train Train No. of Latin Comment Signed Signed Signed 6 638 43 258 Not tested FALEC 8 560 88 704 Not tested FALEC	NJT 1977-78 Jersey Arrow III	85	138,280	69.1	4	1340	80	100	2.3MPH/s		119	14	25000Vac	HL & LL					
No. of cars Lead (End) Lead (End) <thlead (End) Lead (End) Lead (End)<td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></thlead 																			
Modifications assumed Train Test results F470 - Vail No. of Length Train Frain No. of Length Car Train No. of Length Car Train No. of Length Car Train No. of Length Capac. Capac. 6 638 43 258 704 Noi tested 8 600 88 704 9 600 88 704																			
Modifications assumed Highway alignment 6% alignment No. of Length Carr Train No. of Length Carr Train No. of Length Carr Carr E 613 23 258 B 600 88 704														Test	acuite 1.470	liev.			
Train Train No. of Length Car Train Vo. of Length Car Train cars (ft) Cars (ft) 6 638 8 569 8 569 9 560 8 704 9 200 100 1001 tested 101 tested 42.8 201 1612	Trains tested			Modif	ications a	Issumed			2		High	way alignn	hent	9	% alignment		49	4% alignment	
6 638 43 258 74 <th74< th=""> <th74< th=""> 74 74<!--</td--><td>Type</td><td>No. of cars</td><td>Train Length (ft.)</td><td>Car Capac.</td><td>Train Capac.</td><td>Other</td><td></td><td>Comment</td><td><u>v</u></td><td></td><td>peeds 7AB*</td><td>omi) besqel: besqel:</td><td></td><td>pəəd Mar</td><td>(uju əwi pəsdej</td><td>pəs ym</td><td>pəəd 'ßı'</td><td>(uin emi besqel</td><td>рəs ци</td></th74<></th74<>	Type	No. of cars	Train Length (ft.)	Car Capac.	Train Capac.	Other		Comment	<u>v</u>		peeds 7AB*	omi) besqel: besqel:		pəəd Mar	(uju əwi pəsdej	pəs ym	pəəd 'ßı'	(uin emi besqel	рəs ци
8 680 88 704 not rested 42.8 2.01 6192	Amtrak Acela	9	638	43	258				-		5	not tested		Challed o	I) L III	K u	SING		
	NICTD EMU-1	8	680	88	704							not tested		40 B	Puore -	6100	Inclution on grade	grade	
8 682 /0	Montreal AMT MR90	8	682	20	560							not tested		42.8	2-01	6100	AE 7	4.50	0000
1330 1330 1330 1330 1330 1330 1330 1330	NJT 1977078 Jersey Arrow III	14	1190	95	1330							not tested	FAILED	Incuffician	Brakee	EAH CT	EAH ED Stalled on and a	50.1	2200

FGT equipment tested EMU RR 5 of 6

I-70 PEIS												-	-	-	-	-	-
Rail Equipment Analysis															-	-	-
Passenger RR, locomotives & cars																	
Locomotives tested (from Railsim 76 Roling Slock (Brary)	stary)						Arry Downer										
Typa Diseal Incomotions	Length	W Lbs	Wt Tons	Axles	Max Ad	Continuous Power		Aux kW	Max Speed	Max Accel Max Dece		Electric Current	Com	sinuts			
Diesel	6.63	264,000	132	4	25.00%	4250HP	×	53		2 OMPH/s	2.0MPH/S			1	-		_
bormanderuds Freezined ogna zuou itayi ulesei Turbine (Flywheit Equipped), provinciation (Elizabed)	0 1			4	5000	40004		8	Hawost	2 OMPH/s	2.0MPH/s			1	_		
PLOUTING EMU LOW FROME LINESEI LOCOMOUVE	6.2	265,500	130	44	31.00%	3000HP	Y	59 58	HOMPH BOMPH	2.6MPHVs	2.7MPH/s			11			_
Ammax and reetro horn Huzzku-UM (AMD 110 Uresel) F59PHI Amtrak California and Cascade Diesel	58.2	265,500		4 4	22.80%	3200HP 3200HP	> z	28	Hdiwoss	2.0MPH/s 2.0MPH/s 2.0MPH/s 2.0MPH/s	2 OMPHVS			11			
User Defined DE7UAC EMD Low Profile Diesel User Defined P42AC Diesel	75 70	300,000	150	44	33% 33%	4000HP 4250HP	zz	88	100MPH	2.7MPH/s 2.7MPH/s	2.7MPH/s 2.7MPH/s			11			_
Electric locomotives Amtrak AEM7 25KV Electric	51.1	201,750	101	4	20.70%	5790HP	z	123	H4WSE1	2.5MPH/Is 2	2.5MPH/s 2	25000Vac	High				
Cars tested (from Railsim 78 Rolling Slock library)														E.O.			
Type Amtriak WSDOT 1997 Taggo Train Sel Amtriak WSDOT 1997 Taggo Train Sel Amtriak WSDOT 1997 Taggo Train Sel Amtriak Sevin Shore TNU-1 Mignon Sharyy Trainer Cellmon 1993 (M Eluk-Heel California Car MARC Misult/Amasaisi Bi Level Carach MARC Misult/Amasaisi Bi Level Carach Amtriak Superliner II Bi Level Carach	Length 509 509 509 509 50 85 85 85 85 85 85 85 85 85 85 85 85 85	Wt Lbs 357,005 714,010 119,000 119,000 120,000 93,600 93,600 150,000 155,000 155,000 155,000 151,000 151,000 151,000 157,000 157,000 157,000 157,000 157,000 157,000 157,000 157,000 157,000 157,000 150,000 150,000 150,000 150,000 150,000 150,000 170,000 150,000 175,000 175,0000 175,00000 175,0000 175,000000000000000000000000000000000000	Mr Toms 178 5 178 5 535 535 535 535 60 133 8 165 75 75 75 75 75 79 75 79 79 76,5 80 63,80 63,80 63,80 76,50 76,50 76,50 76,50 76,50 76,50 76,50 75,50 75,50 76,50 76,50 77,70 76,50 77,70 76,50 77,70 76,50 77,70 76,50 75,50 76,50 75,50 76,50 76,50 76,50 76,50 76,50 75,500 75,500 75,500 75,500 75,500070000000000	AXlos 13 13 26 26 26 26 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	Capacity 251 251 252 250 250 250 150 94 121 145 145 145 145 146 146 146 146 146	Prop Cap 251 261 264 96 74 74 72 72 72 66 68 68 152	Max Speed 79 79 79 79 79 79 79 71 110 1110 1110 1	Sve Brk Rate 2. 554/PH/15 2. 554/PH/15 1. 00/PH/15 1.	Platform HL HL HL HL HL HL HL HL HL HL HL HL HL	Comments Externely Lightweight, L. Externely Lightweight, L. Would read confiduation Some detaign medication Nould read cateration in Would read cateration in Would read cateration in Has ski storage cateration in Has ski storage cateration in Has ski storage cateration in Used cateration and activity and has ski storage cateration in Has ski storage activity and in Has ski storage cateration in Has science in the storage cateration in Has science in the storage	ghtweight, L amfortable andfortable r Ski Train r edensive in edensive in ge capacity	Comments Comments Comments Outer and Confordabilit. Low Capacity, Could and Confordabilit Could read entersion interior modifications Some design modifications - ski storage Some design modifications - ski storage Some design modifications - ski storage Novid read extension interior modifications Would meet extension interior modifications Would meet extension interior modifications Would meet extension where the modifications where the modifications are extension.	Mions Be Boons Mions Mions				
Allamont 1997 Bombardier Bi-Level Commuter Coach MBTA 1991 Kawasahi BTC Bi-Level Commuter Coach		117,500	58.8 60.3	4 4	139		28	2.0MPHVs 1.0MPHVs	HL SLL	Would need	extensive in extensive in	Would need extensive interior modifications Would need extensive interior modifications	tions				
Diesel Trains tosted				Modif	Modifications assumed	sumed				Highw	alignment	F.	Test results I-470 - Vail 6% alignment	1-470 - Vail		4% alignment	ueut
1ype 2 AMTK P42 & 6 Altamont Bombardier Controuler Ch	No. of cars 6	No. of locos 2	Train Length (ft.) 643.6 0 0 0 0 0	Avg. Car Capec. 125		Other	Comments			-gvA beed2 5 5 5 5 5	emit in the second of the seco	beeu leut Ave.	ewith 2 peeds peeds beeds	(nim) 2 anolia beau leut	BAN BE		(nim) m (anollaD 2 beeu leut
Electric Trains tested			00	Modifi	0 0 Modifications sseumed	poum				Highw	Highway alignment		Test results I-470 - Vall 6% alignment	HTO - Vall		4% alignment	tur
Type 2 Al Pdd & 6 Altamont Rombandiae Commutae Ch	No. of cars	No. of locos	Train Longth (ft.)	Capac.	Train Capac.	Other	Comments			.gvA beed2	beeqal3 emiT (nim)	hwa beeu .gvA.	beeqe	emiT (nim) dvv) beeu	-gvA beed8	beeqel3 (nim)	(ujuu)
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			00		00					E Z	of tested						4

FGT equipment lested RR locos & cars 6 of 6

5/29/01



Appendix C

FGT and RTT Electrification Costs

Rail and Rubber-Tired Capital Costs Electrification System I-70 PEIS

Alternati FGT

Iternatives	S					
FGT	ი	Electric Light Rail Transit, single track	See Tab LRT-Single	\$	210,000,000	
	4	Electric Light Rail Transit, double track	See Tab LRT-Double	\$	400,000,000	
	7	Electric Heavy Rail Transit, single track	See Tab HRT-Single	\$	230,000,000	
	œ	Electric Heavy Rail Transit, double track	See Tab HRT-Double	Ś	400,000,000	
	13	Electric Multiple Unit Passenger RR, single track	See Tab RR EMU-Single	\$	230,000,000	
	14	Electric Multiple Unit Passenger RR, double track	See Tab RR EMU-Double	69	405,000,000	
	15	Electric Supported Monorail, double guideway	See Tab AGS	\$	185,000,000	
			12			
RTT	÷	Dual Mode Bus in separate transitway, peak	See Tab DMB Peak	ŝ	100,000,000	
	12	Dual Mode Bus in separate transitway, both	See Tab DMB Both	θ	185,000,000	
	13	Dual Mode Bus in guided transitway, peak	See Tab DMB Peak	\$	100,000,000	
	14	Dual Mode Bus in guided transitway, both	See Tab DMB Both	69	185,000,000	

185,000,000 235,000,000 235,000,000 235,000,000 • • • • See Tab DMB Both See Tab Electric Bus See Tab Electric Bus See Tab Electric Bus Dual Mode Bus in guided transitway, BRT stations Electric Bus in guided transitway, both Electric Bus in guided transitway, BRT stations Electric Bus in separate transitway, both 15 16 17 18

FGT Electrification cost est r2 G/601/20001629/ Summary 5/29/01 Electric Light Rail Transit Single Track

	MILE 261 EA. 6873 EA. 6873 EA. 6873 EA. 11 EA. 2291 EA. 0 EA. 216 FT. 458220 FT. 458220 FT. 4400 EA. 11 EA. 11 EA. 1400	\$ 18,480 \$ \$ <th>\$ 4,823,280 \$ 309,285 \$ 103,095 \$ 1,155,000 \$ 50,000 \$ 6,873,000 \$ 6,873,000 \$ 6,873,000 \$ 6,48,000 \$ 91,644,000 \$ 110,000 \$ 110,000 \$ 1,760,000 \$ 1,760,000 \$ 1,760,000 \$ 1,760,000</th> <th>0 \$ 2,893,968 5 \$ 185,571 5 \$ 61,857 0 \$ 693,000 0 \$ 693,000 0 \$ 4,123,800 0 \$ 4,123,800 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 5 54,986,400 - 5 54,986,400 6 \$ - 5 56,000 5 - 5 -</th> <th>9 9</th> <th>7,717,248 494,856 164,952 1,848,000</th>	\$ 4,823,280 \$ 309,285 \$ 103,095 \$ 1,155,000 \$ 50,000 \$ 6,873,000 \$ 6,873,000 \$ 6,873,000 \$ 6,48,000 \$ 91,644,000 \$ 110,000 \$ 110,000 \$ 1,760,000 \$ 1,760,000 \$ 1,760,000 \$ 1,760,000	0 \$ 2,893,968 5 \$ 185,571 5 \$ 61,857 0 \$ 693,000 0 \$ 693,000 0 \$ 4,123,800 0 \$ 4,123,800 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 0 \$ 54,986,400 5 54,986,400 - 5 54,986,400 6 \$ - 5 56,000 5 - 5 -	9 9	7,717,248 494,856 164,952 1,848,000
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U						2,816,000
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					69	1
			•	•	69	•
				SUBTOTAL	\$	173,369,056
				20% CONT	69	34,673,811
		- 1			\$	208,042,867
	Cost/Mile	\$ 2,397,360		Cost Rounded to		210,000,000
Syste	System Voltage =25,000 v a.c	00 v a.c.			-	
Syste	System Length=86.8 miles	niles				
A.) B	Base Consist= 4 c	cars				
B.) Ba	Base Energy required in KWH =2004 KWh	red in KWH =200	04 KWh			
C.) Er	Energy required in KVA=B.x1.38=2766KVA	KVA=B.x1.38=2	766KVA			
D.) N	D.) Number of consists required=6	s required=6				
	Energy required one direction=CxD=16,594KVA	ie direction=CxD:	=16,594KVA			
F.) Er	Energy required for both directions=2xE=33,187KVA	r both directions=	=2xE=33,187KVA			
G.) SI	Substations required(one/ stop+2)=11	ed(one/ stop+2)=	11			
H.) S(Substation KVA=F/G=3016KVA	/G=3016KVA				
I.) On	One track with passing siding spaced 4 miles apart	ing siding spaced	d 4 miles apart			

FGT Electrification cost est r2 LRT-Single 5/29/01 Electric Light Rail Transit Double track

		UNITS REQ.	UNIT COST	TOT. UNIT COST	OST	LABOR COST	_	TOTAL COST
12 KV WIRE	MILE	261	\$ 18,480	\$ 4,823,280	,280	\$ 2,893,968	8	
12 KV INSULATORS	EA.	6873	\$ 45		309,285		1 \$	
12 KV SPACERS	EA.	6873	\$ 15	2	103,095	\$ 61,857		164.952
3000 KVA SUBSTATION	EA.	11	\$ 105,000	\$ 1,155,000	000	\$ 693,000	-	
AUTOMATIC TIE SWITCH	EA.	20	\$ 5,000	\$ 100	100,000	\$ 60,000		
CATENARY POLES	EA.	4583	\$ 3,000	\$ 13,749,000	000	\$ 8,249,400	-	21,998,400
CATENARY POLES XO	EA.	55		\$ 165	165,000	\$ 99,000		
CATENARY POLES PASSING	EA.	0	\$ 3,000	ŝ		۰ \$	69	
CATENARY SYSTEM MAIN LINE	Ë.	916438	\$ 200	\$ 183,287,600	600	\$ 109,972,560	-	293.260.160
CATENARY SYSTEM XO	Ë.	5424	\$ 200	\$ 1,084,800	800	\$ 650,880		
CATENARY SYSTEM PASSING	Ę.	0	\$ 200	s	,			
SCADA	EA.	11	\$ 10,000	\$ 110	110,000	\$ 66.000		176.000
CIRCUIT BRK. AUTO RELCLOSE	EA.	99	\$ 40,000	\$ 2,640,000	000	\$ 1,584,000		4.224,000
				¢	,	' S	69	
				ь	,	•	69	ı
				69		۰ ج	69	
				69	,	•	69	
						SUBTOTAL	69	332,043,296
						20% CONT	\$	66,408,659
							69	398,451,955
		Cost/Mile	\$ 4,591,518			Cost Rounded to		400,000,000
	System '	System Voltage =25,000 v a.c.	00 v a.c.				-	
	System	System Length=86.8 miles	iles				-	
	A.) Base	Base Consist= 4 cars	ars				-	
	B.) Base	Energy requir	Base Energy required in KWH =2004 KWh	14 KWh			-	
	C.) Ener	gy required in	C.) Energy required in KVA=B.x1.38=2766KVA	766KVA			-	
	D.) Num	D.) Number of consists required=6	required=6				-	
	E.) Ener	gy required on	Energy required one direction=CxD=16,594KVA	=16,594KVA			-	
	F.) Energ	Jy required for	Energy required for both directions=2xE=33,187KVA	:2xE=33,187K	AN			
	G.) Subs	tations require	Substations required(one/ stop+2)=11	11			-	
	H.) Subs	H.) Substation KVA=F/G=3016KVA	G=3016KVA				-	
	I.) Two tr	ack with cross	Two track with crossover(XO) spaced 8 miles	d 8 miles.			1	

FGT Electrification cost est r2 LRT-Double 5/29/01 Electric Heavy Rail Transit Single Track

			200							
II EM DESCRIPTION	LINN	UNITS REQ.		UNIT COST	10	TOT. UNIT COST	LAE	LABOR COST	Т	TOTAL COST
12 KV WIRE	MILE	260	Ş	18,480	ക	4,804,800	s	2,882,880	69	7.687.680
12 KV INSULATORS	EA.	6,856	ക	45	ω	308,520	Ś	185,112	60	493,632
12 KV SPACERS	EA.	6,856	s	15	Ś	102,840	ŝ	61,704	\$	164,544
10000 KVA SUBSTATION	EA.	12	Ь	350,000	Ś	4,200,000	ŝ	2,520,000	Ś	6,720,000
AUTOMATIC TIE SWITCH	EĄ.	10	ക	5,000	ŝ	50,000	ŝ	30,000	Ь	80,000
CATENARY POLES	EA.	2,286	s	3,000	Ś	6,858,000	Ś	4,114,800	ω	10,972,800
CATENARY POLES XO	EA.	0	Ş	3,000	ຜ	•	ŝ	•	69	Ĩ
CATENARY POLES PASSING	EA.	216	Ş	3,000	Ś	648,000	ŝ	388,800	6	1.036.800
CATENARY SYSTEM MAIN LINE	Ľ.	457,055	s	200	Ś	91,411,000	G	54,846,600	\$	146,257,600
CATENARY SYSTEM XO	FT.	0	Ş	200	ശ		ŝ		69	
CATENARY SYSTEM PASSING	Ę	44,000	ь	200	Ś	8,800,000	s	5,280,000	Ś	14.080.000
SCADA	EA.	48	S	10,000	φ	480,000	Ś	288,000	s	768.000
CIRCUIT BRK. AUTO RELCLOSE	EA.	10	Ь	40,000	မာ	400,000	ь	240,000	Ś	640,000
					φ		ŝ	•	\$	
					ŝ		s	,	\$	
					ω		s	ı	\$	
					G		ŝ	1	\$,
							SUB ⁷	SUBTOTAL	69	188.901.056
							20%	20% CONT	69	37.780.211
									69	226.681.267
		Cost/Mile					Cost	Cost Roundard to	e	220 000 000
									9	230,000,000
	System \	System Voltage = 25,000 v.a.c	00 v.a.c							
	System I	System Length = 86.6								
	A.) Base	Base Consist = 14 cars/consist	cars/consi	st						
	B.) Base	Energy require	ed in KWH	B.) Base Energy required in KWH = 6,843 KWH						
	C.) Energ	gy required in I	VA = B.X	C.) Energy required in KVA = B.x1.38 = 9,443 KWH	H					
	D.) Numl	D.) Number of consists required = 6	required =	= 6						
	E.) Energ	jy required one	e direction	E.) Energy required one direction = CxD = 56,660 KVA	KVA					
	F.) Energ	Energy required for both directions =	both direc	tions = 2xE = 113,320 KVA	3,32	0 KVA				
	G.) Subs	G.) Substations required(one/ stop+2)	d(one/ sto	11						
	H.) Subs	H.) Substation KVA = F/G = 9443 KVA	/G = 9443	KVA						
	I.) One T	rack with Pass	ing Siding	 One Track with Passing Siding Spaced 4 Miles Apart 	Apa	t l				

FGT Electrification cost est r2 HRT-Single 5/29/01 Electric Heavy Rail Transit

			Double Track	ck					
ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	10	TOT. UNIT COST	LABC	ABOR COST		TOTAL COST
12 KV WIRE	MILE	260	\$ 18,480	ŝ	4,804,800	Ś	2,882,880	Ь	7.687.680
12 KV INSULATORS	EA.	6,856	\$ 45	Ś	308,520	ŝ	185,112	\$	493,632
12 KV SPACERS	EA.	6,856	\$ 15	-	102,840	ŝ	61,704	s	164,544
10000 KVA SUBSTATION	EA.	12	\$ 350,000	69	4,200,000	ь	2,520,000	\$	6.720.000
AUTOMATIC TIE SWITCH	EA.	22		-	110,000	ь	66,000	\$	176,000
CATENARY POLES	EA.	4,570	\$ 3,000		13,710,000	\$	8,226,000	ŝ	21,936,000
CATENARY POLES XO	EĄ.	55	\$ 3,000		165,000	Ь	99,000	Ś	264,000
CATENARY POLES PASSING	EA.	0	\$ 3,000	1.254	•	ŝ	•	\$	
CATENARY SYSTEM MAIN LINE	Ŀ.	914,110	\$ 200	Ь	182,822,000		109,693,200	Ś	292,515,200
CATENARY SYSTEM XO	Ę.	5,410	\$ 200	Ś	1,082,000	\$	649,200	S	1.731.200
CATENARY SYSTEM PASSING	FT.	0	\$ 200	ക	•	s	•	ŝ	
SCADA	EA.	72	\$ 10,000	Ś	720,000	ŝ	432,000	69	1.152.000
CIRCUIT BRK. AUTO RELCLOSE	EA.	12	\$ 40,000	\$	480,000	ŝ	288,000	ŝ	768.000
				ക	ĩ	ь	ı	Ś	
				φ	,	ക	Ĩ	ŝ	
				ω	•	\$	ī	Ś	
				Ś	•	\$		\$	
						SUBTOTAL	TAL	ю	333.608.256
						20% CONT	DNT	\$	66,721,651
								ω	400,329,907
		Cost/Mile				Cost Ro	Cost Rounded to	69	400,000,000
								•	
	Svstem Voltage	Voltage = 25.00	= 25.000 v.a.c						
	System Length		niles						
	A.) Base	Base Consist = 14 cars/consist	ars/consist						
	B.) Base	Base Energy required in KWH	ed in KWH = (= 6,843 KWH	KWH				
	0	Energy required in KVA	VA = B.x1.38	11	9,443 KVA				
	D.) Num	Number of consists required =	required = 6						
	-	Energy required one direction = CxD	direction = 0		= 56,660 KVA				
	F.) Enerç	Energy required for both directions = 2xE	ooth direction	s = 2)	<pre>kE = 113,320 KVA</pre>	4			
	G.) Subs	Substations required(one/ stop+2) =	d(one/ stop+2	() = 11					
	H.) Subs	Substation KVA = F/	= F/G = 9,443 KVA	/A					
	1.) Two T	racks with Cros	ssover (XO)	Space	Two Tracks with Crossover (XO) Spaced 8 Miles Anart				
Clartrification cost oct 20					The second se				

FGT Electrification cost est r2 HRT-Double 5/29/01

Electric Multiple Unit Passenger RR Single Track

ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	TOT	TOT. UNIT COST	LABOR COST	COST		TOTAL COST
12 KV WIRE	MILE	260	\$ 18,480	Ś	4,804,800	\$ 2.8	2,882,880	G	7.687.680
12 KV INSULATORS	EA.	6,856	\$ 45	s	308,520		185,112	69	493,632
12 KV SPACERS	EA.	6,856	\$ 15	Ś	102,840	\$	61,704	\$	164,544
9000 KVA SUBSTATION	EA.	12	\$ 315,000	Ś	3,780,000	\$ 2,2(2,268,000	\$	6,048,000
AUTOMATIC TIE SWITCH	EA.	10	\$ 5,000	ŝ	50,000	69	30,000	\$	80,000
CATENARY POLES	EA.	2,286	\$ 3,000	ŝ	6,858,000	\$ 4,1	4,114,800	\$	10,972,800
CATENARY POLES XO	EA.	0	\$ 3,000	ŝ	•		•	\$	6
CATENARY POLES PASSING	EA.	216	\$ 3,000	ŝ	648,000		388,800	\$	1.036.800
CATENARY SYSTEM MAIN LINE	Ę	457,095	\$ 200	Ś	91,419,000	\$ 54,8	54,851,400	\$	146.270.400
CATENARY SYSTEM XO	Ę.	0	\$ 200	Ś	•			69	
CATENARY SYSTEM PASSING	Ę.	44,000	\$ 200	69	8,800,000		5,280,000	69	14.080.000
SCADA	EA.	12	\$ 10,000	69	120,000		72,000	6	192,000
CIRCUIT BRK. AUTO RELCLOSE	EA.	72	\$ 40,000	ь	2,880,000		1,728,000	69	4,608,000
				ŝ	,	69	,	\$	
				\$	1	ь		\$	
				ŝ		s		\$	
				\$	•	\$		\$	
						SUBTOTAL		\$	191,633,856
						20% CONT		\$	38,326,771
								\$	229,960,627
		Cost/Mile				Cost Rounded to		\$	230,000,000
		1							
	System	System Voltage = 25,000 v.a.c.	00 v.a.c.						
	System	System Length = 86.6 miles	niles						
	A.) Base	A.) Base Consist = 10 cars/train	ars/train						
	B.) Base	Energy require	Base Energy required in KWH = 6,191 KWH	31 KV	HN				
	C.) Ener	gy required in I	C.) Energy required in KVA = B.x1.38 = 8,544 KVA	8,544	4 KVA				
	D.) Num	D.) Number of consists required = 6	required = 6						
		gy required one	Energy required one direction = CxD = 561,264 KVA	= 56	1.264 KVA				
	F.) Ener	gy required for	Energy required for both directions = 2xE = 102,528 KVA	2xE	= 102,528 KV/	_			
	G.) Subs	stations require	Substations required(one/ stop+2) =						
	H.) Subs	station KVA = F	H.) Substation KVA = F/G = 8,544 KVA						
	I) One ti	iooch with nocei	1) One track with paceing eiding ending ended	1 million h					

FGT Electrification cost est r2 RR EMU-Single 5/29/01 Electric Multiple Unit Passenger RR Double Track

ITEM DESCRIPTION UNIT UNITS ITS ITS US ITS US ITS US ITS US ITS ITS<				
	REQ. UNIT COST	TOT. UNIT COST	LABOR COST	TOTAL COST
			\$ 2,882,880	\$ 7,687,680
		\$ 308,520	\$ 185,112	\$ 493,632
		\$ 102,840	\$ 61,704	
	\$ 315,000	\$ 3,780,000		9
	\$ 5,000	\$ 50,000	\$ 30,000	\$ 80,000
		\$ 13,710,000	8,226,000	21,9
	\$ 3,000		000'66	100.00
	\$ 3,000			
		\$ 182,822,000	109,693,200	\$ 292.515.200
		\$ 1,082,000	649,200	
	\$ 200	•	-	
	\$ 10,000	\$ 120,000	72.000	\$ 192,000
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi	\$ 40,000	\$ 2,880,000		\$ 4,608,000
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi		، ج	•	
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi		•	,	
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi		•	۰ چ	
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca		, \$		
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca			SUBTOTAL	\$ 335.720.256
Cost/Mile Cost/Mile System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca			20% CONT	
Cost/Mile System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca				\$ 402,864,307
System Length = 86.6 mi A.) Base Consist = 10 ca			Cost Rounded to	
System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca				
System Voltage = 25,000 System Length = 86.6 mi A.) Base Consist = 10 ca				
System Length = 86.6 mi A.) Base Consist = 10 ca	25,000 v.a.c.			
A.) Base Consist = 10 ca	36.6 miles			
	= 10 cars/trains			
B.) Base Energy required in KWH = 6,191 KWH	equired in KWH = 6,19	1 KWH		
C.) Energy required in KVA = B.x1.38 = 8,544 KVA	d in KVA = B.x1.38 = 8	3,544 KVA		
D.) Number of consists required = 6	sists required = 6			
E.) Energy required one direction = CxD = 51,264 KVA	d one direction = CxD :	= 51,264 KVA		
F.) Energy required for both directions = 2xE = 102,528 KVA	d for both directions = 2	2xE = 102,528 KVA		
G.) Substations required(one/ stop+2) = 12	quired(one/ stop+2) = '	12		
H.) Substation KVA = F/G = 8,544	A = F/G = 8,544			
I.) Two Track with Crossover (XO) Spaced 8 Miles Apart	Crossover (XO) Space	ed 8 Miles Apart		

FGT Electrification cost est r2 RR EMU-Double 5/29/01

7 of 12

Electric AGS Double Guideway

ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	_	TOT UNIT COST		I ABOR COST	Ĺ	TOTAL COST
12 KV WIRE	MILE	260	\$ 18,480	-	4,804,800	Ś	2,882,880	Ś	7.687.680
12 KV INSULATORS	EA.	6856	\$	45 \$	308,520	Ś	185,112	Ś	493,632
12 KV SPACERS	EA.	6856		15 \$	102,840	69	61,704	Ś	164,544
2500 KVA SUBSTATION	EA.	44	\$ 130,000		5,720,000	θ	3,432,000	ŝ	9,152,000
AUTOMATIC TIE SWITCH	EA.	42	\$ 5,000	-	210,000	69	126,000	ω	336,000
POSITIVE CONTACT RAIL	Ē	914110		100	31,993,850	69	19,196,310	Ś	51,190,160
NEGATIVE CONTACT RAIL	Ŀ.	914110			31,993,850	Ь	19,196,310	ക	51,190,160
CONTACT RAIL SUPPORTS*	EA.	304703		-	9,141,090	ω	5,484,654	69	14,625,744
POSITIVE CONTACT RAIL (XO)	Ħ.	2164	\$ 35		75,740	ω	45,444	\$	121,184
NEGATIVE CONTACT RAIL (XO)	FT.	2164	\$ 35	-	75,740	ω	45,444	Ś	121,184
CONTACT RAIL SUPPORTS (XO)*	EA.	722	\$ 30		21,660	69	12,996	S	34,656
SCADA	EA.	44	\$ 10,000		440,000	\$	264,000	s	704,000
CIRCUIT BRK. AUTO RECLOSE (a.c1/sub.)	EA.	44		\$	1,760,000	୶	1,056,000	Ś	2,816,000
CIRCUIT BRK. AUTO RECLOSE (d.c4/sub.)	EA.	176	\$ 50,000		8,800,000	s	5,280,000	s	14,080,000
				\$	•	\$		φ	
				ŝ	31	69		\$	ï
				\$	a	69		s	
						SUB	SUBTOTAL	ω	152,716,944
						20%	20% CONT	ω	30,543,389
				_				Ś	183,260,333
		Cost/Mile		-		Cost	Cost Rounded to	69	185,000,000
* Total length contact rail @ 6' spacing									
	Based of	Based on Vancouver Skytrain (LIM)	kytrain (LIN	()					
	System \	System Voltage = 750V d.c.	/ d.c.						
	System I	System Length = 86.6 mile	mile						
	A.) Base	Base Consist = 6 cars/consist	ars/consist	_					
	B.) Base	Base Energy required in KWH = 6842 KWH	ed in KWH	= 684	2 KWH				
	C.) Energ	Energy required in KVA=B.x1.38= 9442 KVA	KVA=B.x1.	38= 94	142 KVA				
	D,) Num	Number of consists required= 6	required= (0					
	E.) Energ	Energy required one direction=CxD= 56,652 KVA	e direction=	CXD=	56,652 KVA				
		y required for	both directi	ons=2	Energy required for both directions=2xE= 113,304 KVA	NA			
		Substations required (one every 2 miles)=44	ed (one evel	y 2 m	iles)=44				
	H.) Subs	Substation KVA=F/G=2575 KVA	G=2575 KV	A					
	I.) Two tr	ack with cross	over (XO) s	pacec	Two track with crossover (XO) spaced 8 miles apart				

FGT Electrification cost est r2 AGS 5/29/01

Dual Mode Bus Peak Direction Only

//RECT	1 11	Citri Citri Citri Citri		121	IOU. UNIT COST	LABOR COST	_	I O I AL COSI
	MILE	194	\$ 18,480	ക	3,585,120	\$ 2,151,072	2	5,736,192
	EA.	13619	\$ 45	ŝ	612,855			980,568
	EA.	13619	\$ 15	ക	204,285	\$ 122,571	4	326,856
	EA.	32	\$ 50,000	\$	1,600,000	\$ 960,000	\$	2,560,000
VITCH	EA.	30	\$ 5,000	ക	150,000	\$ 90,000		240,000
	EA.	4550	\$ 3,000	Ś	13,650,000	\$ 8,190,000	\$ 0	21,840,000
ARY SYSTEM MAIN LINE	Ę.	340462	\$ 75	ŝ	25,534,650	\$ 15,320,790		40,855,440
	EA.	32	\$ 10,000	ക	320,000	\$ 192,000	\$ 0	512,000
	EA.	32	\$ 40,000	ω	1,280,000	\$ 768,000		2,048,000
CIRCUIT BRK. AUTO D.C. E	EA.	96	\$ 50,000	φ	4,800,000	\$ 2,880,000	\$	7,680,000
				ଚ	æ	ج	\$	
				ŝ		ج	\$,
				ŝ	ı	' \$	G	,
						SUBTOTAL	69	82,779,056
						20% CONT	ŝ	16,555,811
							ŝ	99,334,867
		Cost/Mile	\$ 1,540,553			Cost Rounded to	\$	100,000,000
							_	
Sys	stem V	System Voltage = 750v d.c.	d.c.					
Sys	stem L	System Length = 64.48						
A.) I) Base	A.) Base Consist = One Bus	Bus				_	
B.) I) Base	Energy require	B.) Base Energy required in KWH = 328 KWH	8 KW	Ŧ			
C.)) Energ	ty required in h	C.) Energy required in KVA = B.x1.38 = 453 KVA	= 453	KVA			
D.)) Numb	per of consists	D.) Number of consists required = 84/Hour	Hour			-	
E.) I) Energ	ly required one	E.) Energy required one direction = CxD = 38,052 KVA	D = 38	3,052 KVA			
F.) I	Energ	y required for	F.) Energy required for both directions = 2xE = N/A	= 2xE	= N/A		-	
G.)) Subst	tations require	G.) Substations required = System Length x 1 Substation per 2 Miles	ngth x	1 Substation p	per 2 Miles = 32	-	
H.)() Subst	H.) Substation KVA = F/G = 865 KVA	G = 865 KVA	1			-	

Dual Mode Bus Both Directions

\$ 2,139,984 \$ 5 \$ 367,686 \$ 3 \$ 1,152,000 \$ 3 \$ 1,152,000 \$ 3 \$ 90,0000 \$ 3 \$ 1,152,000 \$ 3 \$ \$ 10,342,200 \$ 3 \$ \$ 10,000 \$ 3 \$ \$ 10,000 \$ 3 \$ \$ 30,641,580 \$ 8 \$ \$ 192,000 \$ 2 \$ \$ \$ \$ 12 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	TOT. UNIT COST	LABOR COST		TOTAL COST
EA. 13618 \$ 45 \$ 612,810 \$ 367,686 \$ I/RECT. EA. 13618 \$ 1,152,000 \$ 1,152,000 \$ 330,000 \$ 330,000 \$ 343 3 <td>12 KV WIRE</td> <td>MILE</td> <td>193</td> <td></td> <td></td> <td>\$ 2,139,984</td> <td>L</td> <td>5.706.624</td>	12 KV WIRE	MILE	193			\$ 2,139,984	L	5.706.624
EA. 13618 \$ 15 \$ 204,270 \$ 122,562 \$ 3 IRECT. EA. 32 \$ 60,000 \$ 1,320,000 \$ 1,152,000 \$ 3 <td< td=""><td>12 KV INSULATORS</td><td>EĄ.</td><td>13618</td><td>aas</td><td></td><td></td><td>S</td><td>980.496</td></td<>	12 KV INSULATORS	EĄ.	13618	aas			S	980.496
//RECT. EA. 32 \$ 60,000 \$ 1,920,000 \$ 1,152,000 \$ 30,000 \$	12 KV SPACERS		13618					326,832
EA. 30 \$ 5,000 \$ 150,000 \$ 90,000 \$ 43 VLINE FT. 680924 \$ 3,000 \$ 27,237,000 \$ 16,342,200 \$ 43 EA. 32 \$ 10,000 \$ 30,641,580 \$ 81 EA. 32 \$ 10,000 \$ 32,20000 \$ 192,000 \$ 12 EA. 32 \$ 5,0000 \$ 12,800,000 \$ 12 \$ 2 \$ 2 \$ 2 \$ 2 \$	//REC		32			-		3.072.000
EA. 9079 \$\$3,000 \$\$27,237,000 \$\$16,342,200 \$\$43 NLINE FT. 680924 \$\$75 \$\$51,069,300 \$\$192,000 \$\$81 EA. 32 \$\$10,000 \$\$71,280 \$\$81 \$\$2 \$\$20,000 \$\$1280,000 \$\$72,237,000 \$\$230,641,580 \$\$81 EA. 32 \$\$10,000 \$\$730,000 \$\$730,000 \$\$72,200 \$\$22 \$\$2 EA. 32 \$\$60,000 \$\$730,000	AUTOMATIC TIE SWITCH	EA.	30	14.1422	.242		S	240,000
NLINE FT. 680924 \$ 75 \$ 51,069,300 \$ 30,641,580 \$ 81 EA. 32 \$ 10,000 \$ 320,000 \$ 192,000 \$ 2 2 EA. 32 \$ \$ \$ \$ \$ \$ \$ 2 \$ 2 \$	CATENARY POLES	EA.	6206		Roen		60	43,579,200
EA. 32 \$ 10,000 \$ 320,000 \$ 768,000 \$ 768,000 \$ 2 EA. 32 \$ 50,000 \$ 1,280,000 \$ 7,80,000 \$ 12 EA. 160 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. 160 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. 161 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. 161 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. 2 2 \$ 2,800,728 \$ 2,800,728 \$ 20,000 \$ 185, Cost/Mile \$ 2,800,728 \$ 2,800,728 \$ 2,000,000 \$ 185, \$ 186, System Voltage 750 d.c. \$ 2,800,728 \$ 2,800,728 \$ 2,800,728 \$ 2,800,700 \$ 186, System Length \$ 2,800,728 \$ 2,800,728 \$ 2,800,700 \$ 186, \$ 186, System Length \$ 2,800,728 \$ 2,800,728 \$ 2,800,700 \$ 186, \$ 186, System Length \$ 5,800,728	CATENARY SYSTEM MAIN LINE	E.	680924	9294 (T			G	81,710,880
EA. 32 \$ 40,000 \$ 1,280,000 \$ 768,000 \$ 12 EA. 160 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. 160 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. EA. EA. EA. \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 12 EA. EA. EA. EA. EA. \$ 50,000 \$ 4,800,000 \$ 12 EA. EA. EA. EA. EA. \$ 50,000 \$ 12 \$ 50,000 \$ 12 \$ 50,000 \$ 12 \$ 50,000 \$ 12 \$ 50,000 \$ 12 \$ 131 EA. EA. EA. EA. EA. \$ 5,00,000 \$ 12 \$ 131 F. Cost/Mile \$ 2,809,728 EA. \$ 2,00,000 \$ 131 \$ 136 CostRounded to \$ 2,809,728 EA. \$ 2,000,000 \$ 2,000,000 \$ 138 \$ 136 System Length = 64.48 EA. \$ 2,809,728 EA. \$ 2,800,000 <	SCADA	EA.	32				S	512.000
EA. 160 \$ 50,000 \$ 8,000,000 \$ 4,800,000 \$ 5 \$ - \$ 5 5	CIRCUIT BRK. AUTO A.C.	EA.	32				\$	2,048,000
\$ - \$ - \$ \$ - \$ - \$ \$ \$ - \$ - \$ \$ 1 \$ - \$ - \$ \$ 1 \$ 1 \$ - \$ \$ - \$ \$ \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ 1 \$ \$ 1 \$ \$ 1 \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1 \$ \$ 1	CIRCUIT BRK. AUTO D.C.	EA.	160		43		Ś	12,800,000
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FGT Electrification cost est r2 DMB Both 5/29/01 Electric Bus Both Directions

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FGT Electrification cost est r2 Electric Bus 5/29/01

List of simplying assumptions for sheets 2 to 11.

- Primary feed is a continuous 3 phase, 3 wire 12KV feed from start of line to end of line.
 - Three 12KV insulators used per catenary pole for the primary feed.
- Three 12 KV spacers are used between each catenary pole to keep the 12KV wires separated on the primary feed.
 - All Kw requirements are converted to Kva to account for power factor(0.85) and system effenices(0.85) Catenary Poles are spaced approximately 200 feet apart.
 - Catenary Poles are also used to support the 12KV primary system.
- Catenary system consists of main messenger, auxiliary wire and contact wire. - - ha fed c b a
- Automatic tie switch provided outside of each substation to tie power sections together in an emergency.
 - Four automatic reclose breakers provided, two to isolate the transformer, two for section breakers.
 - Other assumptions are shown as shown on each sheet.

COSTS

750v dc Substation/rectifier, cost = \$52/Kw 1 conductor 12 KV wire (4/O@\$3.50/ft.) 25KV Substation cost = \$35/KVA 1 SCADA/substation



Appendix D

Feeder Bus Operations Summary

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feeder S
5/29/01

Metro Ops DIA/C470

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Summary of Feeder Operations

Operating Costs

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I-70 Feeder Bus Services			
Node/Stop	Current Operator	Cost/Hr (1998)	Cost/Hr (1998) Description
Origin to C-470 Evergreen/US 6 Idaho Springs Empire Loveland Silverthorne Keystone (via Silverthorne/Dillon) Frisco Copper Vail	RTD RTD No No Summit Stage Resort System Summit Stage Summit Stage Vail Transit	\$ 87.00 \$ 62.00 \$ 62.00 \$ 62.00 \$ 34.00	Comprehensive services incl LRT87.00P&R services; RTD \$87/hour62.00Comprehensive; 6am to 11pm (to 1215am in Winter)6am to 12mid62.00Comprehensive; 6am to 11pm (to 1215am in Winter)62.00Comprehensive; 6am to 11pm (to 1215am in Winter)62.00Varied services; 6am to 11pm (to 1215am in Winter)62.00Comprehensive; 6am to 11pm (to 1215am in Winter)62.00Varied services; 6am to 11pm/12mid

5/29/01 feeder Existing Ops

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Stations

5/29/01 feeder Stations

g:200/1629/feederbus

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Peak	75	61	30	56	16	95	152	325	415		21400	4,608	100%
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Totals 78,603,100 184,456,882 Sources L70 Mountain Consider Transit Learning 10,000	603,100		2,329,806 \$	62	33.7								

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Appendix D TranSystems Maximum Gradients for Fixed Guideway Transit Systems (Except Monorail) Proposed for the I-70 Mountain Corridor January 2001 This page intentionally left blank.

DRAFT 6

Maximum Gradients for Fixed Guideway Transit Systems (Except Monorail) Proposed for the I-70 Mountain Corridor

Prepared for the Colorado Department of Transportation and the Mountain Corridor Advisory Committee

> Prepared by Mark C. Walbrun, PE & Gary R. Johnson, PE

TranSystems Corporation January 5, 2001

INTRODUCTION

The portion of Interstate 70 that traverses the Rocky Mountains in Colorado passes through a very challenging environment in which to construct any type of ground based transportation system. This segment of I-70 which begins in Denver near highway C-470 and proceeds west to Eagle is known as the I-70 Mountain Corridor. It is currently being studied as part of a Programmatic Environmental Impact Statement (PEIS) that among other things will evaluate the potential of alternate transportation modes to alleviate the severe congestion on the existing highway.

A number of Fixed Guideway Transit (FGT)^a systems have been proposed to mitigate the existing and future congestion along the Mountain Corridor. Each of these technologies differs in a number of technical aspects related to their operating performance on steep grades. While it has been generally acknowledged that Advanced Guideway Systems such as Maglev and Monorails will have little trouble operating on grades up to $10\%^1$, questions have been posed as to the capabilities of conventional rail systems in this environment. Since these rail systems would be expected to operate within or alongside the existing I-70 corridor, they would need to traverse gradients similar to the existing highway grades that vary from level to a maximum of 6.7% for a short distance near the Eisenhower Tunnel.²

The purpose of this report is to document current design practice and criteria used for the construction of various FGT technologies, and particularly how they relate to the I-70 Mountain Corridor. The definitions of Advanced Guideway Systems (Maglev and Monorail), Passenger Railroads, and Rail Transit (Light Rail Transit (LRT) and Heavy Rail Transit (HRT)) are taken from the "I-70 Mountain Corridor PEIS - Identification of Transit Alternatives (Draft Final Report)" by TranSystems, dated July 26, 2000. Only rail based systems will be evaluated in this report. Assumptions underlying the applicability of Advanced Guideway Systems to the corridor will be verified during compilation of the Draft Environmental Impact Statement.

DISCUSSION

The generally accepted maximum grade^b for any passenger carrying steel wheel on steel rail system is about 10% (this is called the adhesion limit³). Beyond that limit, the vertical force vectors of the vehicle moving along the grade are able to overcome the friction between the two steel surfaces that propel or retard a train wheels. Any rail system built in excess of the adhesion limit requires supplemental traction and braking

^a Fixed Guideway Transit or FGT is a term used to refer to a group of transit technologies that function in a fixed guideway which includes Advanced Guideway Systems (Maglev and Monorails), Passenger Railroads, and Rail Transit (Light and Heavy rail transit).

^b Grades (gradients) are expressed in terms of a percentage of vertical change over a given horizontal distance. A 1% grade represents a vertical change of 1 foot over 100 feet of horizontal distance.

Maximum Gradients For Fixed Guideway Systems

12#

assistance such as redundant rubber tired wheels, a rack, or a cable line (called a *funicular*). Maximum design grades (which are well under the adhesion limit) for railroads and rail transit systems are based on a number of factors including available traction power, braking characteristics, wheel/rail adhesion, vehicle weight, and economics.

The typical "general purpose" railroads that crisscross the US are normally constructed using a maximum gradient of 2% or less.⁴ This is not, however, the upper limit of their effective design grades, but represents a compromise between **right-of-way** costs, **construction** costs, and freight train **operating** expenses. When difficult topography dictates other approaches, grades can be much steeper as evidenced by the numerous freight lines throughout in Colorado that routinely operate on grades of over 4%.⁵ Rail Transit systems, such as the Denver RTD Light Rail lines, are often built with maximum gradients of up to 6% when transitioning to aerial structures.⁶

The 127 mile I-70 Mountain Corridor has the following generalized grade characteristics:

- 78 miles (61% of the route) on grades less than 3.0%
- 37 miles (29% of the route) on grades between 3.0% and 6.0%
- 12 miles (10% of the route) on grades over 6.0% [the maximum highway grade of 6.7% (which is posted as 7%) occurs near the Eisenhower Tunnel]

Alignments on grades at or less than a 3% would present no unusual operating problems for any rail based system. Grades between 3% and 6% are nearing the upper limit of standard Passenger Railroad construction, but well within parameters for Rail Transit (LRT and HRT) technologies.^c

Grades of 6% to 7% would require a carefully designed alignment and special performance vehicles, but are still within acceptable limits for Rail Transit (LRT and HRT) technologies.

CURRENT PRACTICE

In North America, new general purpose railroad lines are usually designed for a maximum of 1% grade, with some exceptions up to 2%. For Passenger Railroads, Amtrak (operator of most of the passenger railroads in the US) limits grades to a maximum of 2.5% unless special approval has been granted by their Chief Engineer.⁷ The TGV, a high speed passenger railroad in France, was constructed with maximum grades of 3.5% to save tunneling costs and allow co-location with highways – a fact that

^c Optional higher performance motors and braking systems may be required on transit vehicles operating on long grades of greater that 3%.

was highlighted in their prospectus for proposed North American operations.⁸ Rail Transit (LRT and HRT) systems are usually designed to operate within 4% gradients, using higher grades for short transition segments.⁹

The effects of gradient on operating speed are closely tied to the curves within any given segment of a rail system. Speed restrictions for gradients are generally based on curvature, not the grade itself. Downgrades often have speed restrictions to avoid building too much momentum prior to encountering restrictive curves, although operations on even steep downgrades can be routinely found at 40 mph. The PATCO HRT system in Philadelphia operates over a long 6% grade to and from the Ben Franklin Bridge at 50 mph. The French TGV Passenger Railroad operates at 185 mph on its 3.5% grades.

REFERENCES

The American Railway Engineering and Maintenance of Way Association (AREMA) sets the recommended practices for the construction and maintenance of railways in North America. Chapter 12 of its Manual for Recommended Practices deals with passenger railways and contains the following excerpt under Part 2 Section 6.3.5 – "Grades":

"Commuter rail [Passenger Rail]^d, while using existing roadbeds in most cases, should utilize desirable grades of under 2% for mainline operations. Desirable maximum grades for heavy rail [HRT]^d construction are approximately 3%. Light rail [LRT]^d vehicles usually possess the ability to climb steeper grades than heavy rail equipment. New construction should reference existing operating properties to establish desirable grades. Care must be taken in considering propulsion methods and weather considerations in planning for gradients. A major criterion is vehicle braking performance on descending grades; systems utilizing automatic controls usually require that grades within 1,000 feet of stations be limited to 3% or less. See Table 2-2 for examples of existing systems."

Category	Mainline	Exceptions	
Commuter Rail	3%		
Heavy Rail	6%	7%	111 ·
Light Rail	5-6%	7%	
People Mover	6%	8%	

Table 2-2. Typical Maximum Gradient Examples

^d "Passenger Rail", "LRT" and "HRT" is added by the author for the clarification of terms only.

Maximum Gradients For Fixed Guideway Systems

The Transportation Research Board (TRB), a division of the National Research Board of the National Academy of Sciences, published a seminal report entitled "Track Design Handbook for Light Rail Transit¹⁰ (Report 57) as part of its Transit Cooperative Research Program. Section 2.4.4 dealing with Maximum Vertical Grades for vehicles states that:

"The maximum allowable route grade is limited by the possibility that the LRV (Light Rail Vehicle) could stall or the traction motors overheat. This is the steepest grade that the LRV can negotiate. A short grade that the LRV enters at speed should not be a problem up to about 6%. Above that the operational requirements should be reviewed. Grades of up to 10% are possible. At grades between 6% and 10%, wheel-to-rail slippage may occur in poor conditions, such as when ice or wet leaves are on the rail. This may result in wheel flats during breaking or rail burns during acceleration."

Section 3.3.3 dealing with Vertical Grades in track states that:

"Maximum grades in track are controlled by vehicle braking and tractive efforts. ...As a guideline, the following profile grade limitations are recommended for general use in LRT design:

Main Line Tracks: Maximum Sustained Grade, Unlimited Length – 4.0% Maximum Sustained Grade, Up to 2500' Between PVIs – 6.0% Maximum Short Sustained Grade, Up to 500' Between PVIs – 7.0%''

The distances between PVIs (Points of Vertical Intersection) cited above are for vehicles equipped with standard motors and brakes. High performance motors and brakes are available that will allow virtually continuous operation at those grades.

A frequently used textbook for railroad engineering, <u>Elements of Railroad Engineering</u>,¹¹ contains the following excerpt:

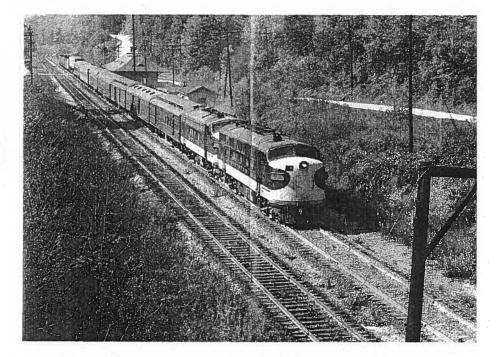
"Eastern trunk lines seek grades of 0.3 per cent or under against their heavier traffic, while grades of 4 per cent are frequent in the Rocky Mountains...but heavier grades, approximating 6 per cent, exist and are operated on some mountain, mine, and logging roads. ...A locomotive having only driving wheels and no tender could theoretically just maintain itself at a uniform slow velocity on a grade of about 24.75 per cent. The steepest trolley road grades are about 15 per cent."

Although the locomotive cited above is presumably a steam unit, current diesel locomotives have similar capabilities.

Two key railway design manuals do not address maximum grade issues. The frequently used textbook "Railroad Engineering"¹² by William W. Hay, Professor Emeritus of Railway Civil Engineering, University of Illinois contains no comment on maximum grades achievable by railroads. The widely used "Transportation Planning Handbook"¹³ published by the Institute of Transportation Engineers similarly contains no reference to maximum railway gradients.

EXAMPLES

The steepest grade being currently operated on a railroad branch line in the United States is the Boeing Branch of the BNSF at Mukilteo, Washington serving the aircraft plant at Everett with grades approaching 6.0%.¹⁴ The highest grade being currently operated on a mainline railroad in the United States is the 4.7% grade on Saluda Hill in North Carolina on the Norfolk Southern.¹⁵ This line is in active use for freight service and once operated numerous passenger trains. The photo below by H. W. Bundy Jr. taken in 1963 shows Southern Railway train 28, the Carolina Special, preparing to descend the famous grade on its journey from Knoxville to Columbia.



SR 28 on 4.7% Saluda Hill Grade 1963

In a tract entitled "SMARTrans - Sensible Mountain Area Railway Transport"¹⁶ by Edward Stewart Wright the author extols the virtues of rack assisted railway service. He acknowledges a 9% adhesion limit (page 38) for regular railway operations but goes on to examine the use of rack assists, common in Europe, to handle gradients up to 30% (he suggests the use of 17% grades for short distances in the Mountain Corridor). He also describes a conventional narrow-gauge railway that once operated near Georgetown, Colorado that used 7% grades with steam locomotives and the Uintah Railroad which operated with 7.5% grades. He also notes that a key Union Pacific (ex D&RGW) line over Tennessee Pass was operated for over a century on 4% grades for both freight and passenger trains. In addition, he notes that many tourist railroads in the region, including the Cumbres & Toltec Scenic, Leadville, and Georgetown railways routinely operate over 3% to 4% grades with vintage equipment. The author also notes that the Denver RTD Light Rail line operates over 6% grades on the newly-opened extension to Littleton.

CONCLUSIONS

The I-70 Mountain Corridor alignment presents challenges to any rail system designer, but not beyond what any complex project would entail.

It is important to note that operating restrictions on grades are caused by numerous factors. As long as the grade is below the adhesion limit, the next most important factor is traction power and braking characteristics of the vehicle. These are essentially mechanical limitations and can be overcome with special vehicle designs. Railway equipment that was specially designed for mountain use was common in the United States before the 1950s. Standardization of locomotive design has eliminated the use of specialized units in high grade areas in favor of using multiple units operating together. In most cases, typical Passenger Railroad and Rail Transit equipment can be modified to handle long grades through the use of special duty traction motors and multi-stage regenerative braking systems.

A more important limitation on grades is the economic factors. Operating railroads on higher gradients exacts a significant cost in diesel fuel (or electric power). When many railways were originally constructed in the 1800s, the fuel cost was very high and constructing a longer, gentler gradient resulted in more efficient use of the available energy. This led to the basic design standards still in use today. Importantly, <u>current</u> economic forces would now favor use of a higher gradient to stay within existing transportation corridors, rather than the incur high costs of permitting, right-of-way acquisition, and construction.

Over 78 miles of the corridor (sections at less than 3% grade) could be built using Passenger Railroad or Rail Transit system technology with no special restrictions and operated at speeds up to 79mph (or even higher – up to 110mph - with special signal modifications). The other sections of the I-70 Mountain Corridor (those having grades in excess of 3%) would require a combination of both vehicle and alignment enhancements to support such rail systems.

The 37 miles of moderate grade on the I-70 corridor (3% to 6%) can easily accommodate Rail Transit (LRT and HRT) systems, such as the Denver RTD Light Rail system, at speeds in the 55 mph to 65 mph range. Some propulsion/braking system modifications [•]Maximum Gradients For Fixed Guideway Systems

may be necessary to accommodate long grades (depending upon the type of vehicle chosen). It could also be operated as a Passenger Railroad with slightly lower speeds on curves due to differences in braking profiles between Passenger Railroads and Rail Transit equipment. It could also be utilized as a freight railroad bypass corridor with speeds in the 30-45 mph range.

The remaining 12 miles at high grades (greater than 6%), if not mitigated, would require somewhat slower operating speeds depending upon the track curvature The segments of greater than 6% grade are a small portion of the overall line and not a major contributor to the end-to-end trip times. Mitigation of the greater than 6% grades could be achieved by employing the following techniques:

- Build a lesser grade bypass around the Eisenhower tunnel. One such alternative which has been suggested in via Keystone. Use of the existing but never used pilot bore tunnel should be investigated for feasibility.
- Build a new rail tunnel under the Continental Divide entering and leaving at a lower elevation than the Eisenhower. It is easier (and less expensive) to build long rail tunnels than highway tunnels due to their relative size and lower ventilation requirements.
- Build a direct rack assisted rail line for rail transit operation over a higher grade route using a straighter alignment to save time (unlikely to be fast enough to justify the rack expense and maintenance).

The I-70 Mountain Corridor presents many challenges to rail system designers. The grades along the existing corridor are to be respected but do not present an unsolvable obstacle to implementation of a rail based transportation system. Rail systems currently operate within corridors with equivalent grades and over similar terrain. The final determinate as to the potential performance of any rail based system involving long, steep grades can be calculated based on supplied vehicle braking and acceleration curves applied over a proposed grade profile and curve alignment (called a Train Performance Calculator). This program, once all of the parameters have been identified, can provide end-to-end transit times, aggregate fuel use, and carrying (tonnage) potential of any rail based system under consideration.

The potential of a rail transportation system to provide significant congestion mitigation along the I-70 Mountain Corridor is high and needs to be carefully evaluated and the results considered as part of the PEIS.

Maximum Gradients For Fixed Guideway Systems

¹ Correspondence with Robert Dorer, Volpe Transportation Institute (United States Department of Transportation). December 14, 2000.

² Mountain Corridor Profile, TranSystems Corporation 1999

³ "Railroad Engineering" by William W. Hay, Mgt. E., M. S. John Wiley & Sons, Inc. Page 87. 1953

⁴ "Manual of Recommended Practices" by the American Railway Engineering and Maintenance-of-way Association (Chapter 12, Part 2, Section 6.3.5). 2000

⁵ [add UPRR track chart reference here]

⁶ [add RTD track chart reference here]

⁷ "Amtrak Safety Limits and Specifications for Maintenance and Construction of Track – MW1000" by the National Railroad Passenger Corporation. January 1, 1992

⁸ op cit. Dorer. TGV actually proposed a maximum grade of 5% in their Texas Triangle proposal.

⁹ "Track Design Handbook for Light Rail Transit" published by the Transportation Research Board as part of the Transit Cooperative Research Program (Report 57). 2000

¹⁰ Ibid.

¹¹ "Elements of Railroad Engineering" by William G. Raymond, Dean of the College of Applied Science – State University of Iowa; Henry E. Riggs, Professor Emeritus of Civil Engineering – University of Michigan; Walter C. Sadler, Professor of Civil Engineering – University of Michigan. John Wiley & Sons, Inc. 1947

¹² op cit. Hay.

¹³ "Transportation Planning Handbook" by the Institute of Transportation Engineers. [add current publisher and date]

¹⁴ [add BNSF track chart reference here]

¹⁵ [add NS track chart reference here]

¹⁶ SMARTrans Sensible Mountain Area Railway Transport" by Edward Stewart Wright. bookpublishers intercontinental ltd. 2000

Appendix E TranSystems I-70 Programmatic Environmental Impact Statement Transit Summary Document January 2003 This page intentionally left blank.

I-70 Programmatic Environmental Impact Statement

Transit Summary Document





Transportation RANSPORTATION



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INTRODUCTION

A number of transit alternatives to highway expansion are available to handle the growth in traffic along the I-70 Mountain Corridor. These alternatives consist of various forms of rubber tired, rail based, and promising new technologies for ground transportation. Each of these alternatives has a large number of variations due to options in guideway technology, line configuration, propulsion source, and design capacity. These differences affect the initial capital costs to construct the proposed system, the unit cost of the vehicles, the number of vehicles required to meet proposed ridership demand and schedules, and the costs to operate and maintain the system. These option choices significantly affect the ultimate capacity of the proposed system, the overall running time between end points, the energy consumption per passenger, and the environmental impacts of the system.

SUMMARY OF TRANSIT MODES TESTED

The modes that survived Level 2 Screening for the Denver (Jefferson Station, at I-70/US 6/C-470) to Vail segment included:

- Diesel Bus, running either on a Transitway or a Guideway
- Dual-Mode Bus in Guideway
- Diesel Light Rail Transit
- Electric Light Rail Transit
- Heavy Rail Transit
- Passenger Railroad Electric Multiple Unit
- Conventional Monorail
- Advanced Guideway System (Magnetic Levitation)

Redefining/Refining of Modal Alternatives

Some consolidation of these modal alternatives was made at the beginning of the current round of analysis. Further details regarding specific characteristics of each mode tested in this phase may be found in the Train Performance Calculator section.



RTT Alternatives

There have been no changes in the bus technologies utilized in this phase of the study. The I-70 Mountain Corridor is fairly unique. To reduce congestion riders will need to be attracted out of their cars, the buses would need to have high levels of amenities. Because of the distances/travel time involved, typical city bus seating would not be appropriate. Intercity buses have more comfortable seating (although legroom is frequently set too tight) but the single door and steps lead to slow loading/unloading. The typical exterior ski racks installed on resort area shuttles would not be appropriate for long trips at high speed. Rest rooms are required. However, food/beverage service probably cannot be considered because this requires an attendant, which cannot be justified by the relatively small number of passengers served. The buses tested were based on typical, currently-available intercity/suburban buses, with conventional, high floors, but it is assumed that an additional door would be provided, probably at floor height, to speed passenger movement and shorten stop times (this would require corresponding high level platforms at stations). Interior ski racks, perhaps under the floor, would be provided.

Diesel Bus, Transitway or Guideway





the low side barriers of the guideway. The low-cost addition of the guidewheels (and a few other small modifications for guideway operation) does not interfere with the ability of the buses to continue off the guideway, allowing through operation on normal highways.

Dual Mode Bus on Guideway

The dual mode bus was modeled as an articulated

These buses were assumed to have a seated capacity of 52, length of 45 feet and weigh 38,000 lbs. The Diesel buses were assumed to have a maximum speed of 70 mph. The Diesel buses were assumed to have a 450 HP engine (400 HP buses are currently typical for

intercity use) for climbing the steep grades. This is the largest engine size

that it is considered feasible to install in a bus. The "Guideway" refers to a travel way that is somewhat like a rail line in that the buses are equipped with single guidewheels at the front corners of each side, which ride against







(bending) bus 60 feet long with seating capacity for 68 passengers and weighed 53,000 lbs. In its electric mode, the dual mode bus runs off power rails integrated into the guideway with a nominal line voltage of 750 DC. Traction motors with a continuous rating of 700 HP were assumed. It was assumed that these buses would also be equipped with a 450 HP diesel engine for use off the guideway and for backup in case of electric power failure. The dual mode bus had a maximum speed of 75 mph. Dual mode buses are not common. The only fleet currently in service in the U.S. is utilized by King County Metro (Seattle). These 60 foot long articulated buses were built in 1982 by Breda (Italy) and are utilized for express bus runs which generally operate in diesel mode in the outlying areas including extensive operation on expressways and enter downtown using electric power obtained from overhead trolley wire in the Downtown Bus Tunnel. A small fleet of dual mode buses with similar characteristics, for use in a similar service, is currently under construction in Germany for Boston. The practical maximum speed for overhead trolley wire is about 45 mph, there are no known examples of electric bus operation faster than this. For the higher speeds required along the I-70 Mountain Corridor, it would be necessary to either utilize overhead catenary wire, as used by electric LRT, for high speed segments, and electric railroads, or power rails integrated with the guideway, very similar to the power collection utilized by people movers, monorails, etc. The latter technology has been assumed.



Rail Transit

The four rail modes were consolidated into one called Rail Transit (see discussion on page 7). This allowed the dropping of consideration of the 6% alignment. This alignment would have involved leaving the existing I-70 alignment for considerable lengths along the route, including extensive tunneling requirements. A special Train Performance Calculator run confirmed that the "heavy rail transit" train developed for Level 2 Screening could handle the occasional short segments of 7% grades of the highway alignment (in the same way as the electric light rail trains)





with minor degradation of performance. The Diesel Light Rail trains could operate on these grades, but had the disadvantages of relatively slow operation and higher noise levels. The short trains provided by light rail, either diesel or electric, are not capable of handling the number of passengers identified in the ridership estimation. The Rail Transit Equipment considered in this phase will be able to be operated in trains, tentatively up to 10 cars in length. These would have end doors (allowing passengers to walk through the train looking for seats and to reach a food/beverage service car

and crews to inspect tickets) yet would still be able to operate onto RTD LRT lines (except those with on-street operations). Thus, it was necessary to drop light rail options. It was also concluded that, since a rail line with either 6% or 7% could not be operated with equipment routinely operated on the national railroad system, there was no reason to operate the FRA (Federal Railroad Administration) compatible Passenger Railroad Electric Multiple Unit equipment. Since there will be no interchange with the national railroad system, cars need not be built to meet FRA buff strength requirements, greatly reducing weight.

The rail transit train that was tested was designated the "EMU R2", the same train as tested in Level 2 screening as the Heavy Rail Transit Alternative. This was developed to meet the specific needs of the corridor. It used consists of a 5-car unit with a 2-unit limit. All axles are powered. Regenerative, disc and emergency track brakes would be available. Top speed was set at 80 mph. The train was tested with overhead catenary power supply at 25,000 V A.C., although it is assumed that trains would be capable of also drawing power from 750 V D.C. catenary if required for through-running over RTD lines in Metro Denver. This would avoid the need for passengers to change vehicles. Each car has an average seated capacity of 59 people allowing space for skis, luggage and some space dedicated to food service. The trains are expected to have food on board and other amenities suited to traveling



between the airport and Vail. Cars were assumed to have two quarter point doors, each about 36" wide. Cars will have flat floors about 28 inches above top of rail. The platform height at each station will match this for easy boarding with skis and luggage. A real world example of a type of train that would appear to be very suitable for the I-70 Mountain Corridor is the Swiss Federal Railways RBDe560 series regional train (see Photo).

Monorail/Advanced Guideway

The CIFGA Monorail and Advanced Guideway System have been somewhat redefined; traditional monorail and urban maglev. The conventional monorail would utilize the technology in service since the 1950s at Disneyland, now under construction in Las Vegas and in use on many systems in Japan and elsewhere. This is called a "straddle" or Alweg monorail and uses rubber tires on concrete beams. The Advanced Guideway System has been refined to utilize the emerging technology now known as "Urban Maglev." CIFGA has recently chosen this technology.



The conventional monorail was created based on information provided by Hitachi, the largest producer



of monorails worldwide, for the largest produced of monorails worldwide, for the largest of its three model sizes. These trains are available "off-the-shelf" and specifications are well documented. The vehicle straddles a guideway. The large model that has been chosen has a flat floor. The bogies have rubber tires that ride both on top of and on the sides of the narrow guideway beams. It is assumed that the trains will be six cars long holding 70 seated passengers each. It is also

assumed that the monorail will have regenerative and disk brakes. Top speed is limited to 60 mph by the use of rubber tires. Nominal line voltage for the conventional monorail is 7420 AC. It is also assumed that doors will have level boarding. Again, standard monorail (non-FRA compliant) car body construction was assumed.

Maglev systems have been under development since the 1960s. Two types are being actively tested. One is a German attraction-based design where the magnets on the track are attracted to electromagnets on the car, which are used to levitate the car for high speed running. Also, a Japanese repulsion based design where the magnets on the track push the car away to levitate it in a trough for high speed running.



The German design, which was being planned for a new line from Berlin to Hamburg, was recently defunded. However, the German consortium is installing 20-mile a demonstration line between Shanghai and its airport. Tests runs are scheduled to start in 2003. Top speed is planned for about 250 mph. The Japanese design is still undergoing full scale testing in a section of the planned track built outside of Tokyo. In the U.S., active studies of maglev implementation are underway

for a route between Pittsburgh and its airport and in the Washington-Baltimore corridor.

Although both systems would be capable of operating in the I-70 Mountain Corridor, neither is sufficiently advanced to generate reliable cost and performance data. Data provided by CIFGA was utilized in this study.

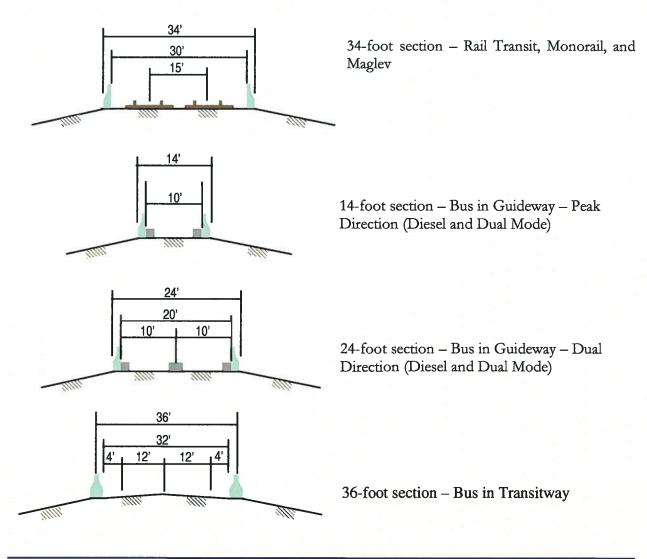


ALIGNMENT DESCRIPTION

The FGT alignment analysis process was undertaken as part of the I-70 Programmatic Environmental Impact Statement to determine the character of the physical footprint of the transit alternatives on the I-70 Mountain Corridor generally from C-470 to Vail (as further detailed below). Built on the results of the Level 2 Screening Report, this report documents the analysis of alignments that support the vehicle technologies surviving second level screening. Alignment Studies were required to estimate capital costs.

Typical Section Development

Based on the similarities in the various technologies listed above, four (4) basic typical sections were established. The dimensional elements necessary to accommodate just the transit modes are four basic sections are shown below:





Alignment Alternatives

Again, grouping common characteristics of the remaining technologies, an alignment design criterion was determined. From the table below, 2 basic alignment alternatives were initially selected for detailed study: the 6% FRA-compliant and the Highway (7%) alignments.

Grade	Criteria	Typical Section	Limits	Technologies
6%	Suitable for Heavy Rail Transit and Passenger Railroad EMU (FRA Compliant)	34'	This alignment was developed for the entire corridor from the C-470 area to Vail and included one major sub-alternative (see below)	All technologies, (heavy rail and passenger rail technologies were basis of typical section.)
Highway (7%)	Non-FRA-compliant, AASHTO	34'	C-470 to Vail excluding Clear Creek County (J.F. Sato & Associates incorporated appropriate space for the various typical sections in their analysis of the highway widening alternatives)	Rail, Monorail, and Maglev
Highway (7%)	AASHTO	14' 24'	C-470 to the Eisenhower Tunnel* excluding Clear Creek County (J.F Sato & Associates incorporated appropriate space for the various typical sections in their analysis of the highway widening alternatives)	Diesel and Dual Mode Bus
Highway (7%)	AASHTO	36'	C-470 to the Eisenhower Tunnel* excluding Clear Creek County (J.F. Sato & Associates incorporated appropriate space for the various typical sections in their analysis of the highway widening alternatives)	Diesel Bus

*Initial limits from C-470 to Dillon, also includes option from the Hyland Hills Interchange to the east side of Eisenhower/Johnson Tunnels

It was not the intent to limit the technology to any one alignment. For instance, all technologies could use the 6% Heavy Rail/Rail Passenger alignment. The intent was to show the most representative range of the operating character of FGT technologies. In the technology operational analysis, technologies were assigned to an alignment alternative based on where they would best perform.

Several of these alternatives had variations of grade and alignment creating more than one option for each alternative. Several of the alternatives followed the existing I-70 roadway and one of the alternatives did not. The alternatives that followed I-70 were evaluated by TranSystems from the Hogback to Vail, excluding Clear Creek County (the portion in Clear Creek County was evaluated by JF Sato using the same criteria). The 6% alignment that did not follow the existing I-70 roadway was assessed from the Hogback through Vail and included Clear Creek County. Below is a list of the criteria that were used to develop the various alternatives.



6%	Design Cr FGT (Heavy Rail, Rail Passenger		/ (Light Rail, RTT)
Design Stand	lards	<u>6%</u>	HWY
— • • • • •	Maximum Grade	6%	7% +
-	Vertical Curves		
	 Crest (K min value) 	500	290 (70 mph, SSD)
	 Sag (K min value) 	1000	150 (70 mph)
—	Horizontal Criteria		
	Minimum Curve Radius	955'	750' (45mph)

Footprints for Fixed Guideway Transit Alignments

The FGT alternative includes monorail, rail, bus-in-guideway, and bus-in-transitway. To simplify the analysis, it was assumed that the impacts would be identical for templates with the same overall width even if the technology specific configuration within the templates differed.

If possible, the Heavy Rail/Rail Passenger alignment (6%) was located immediately adjacent to the

Survey Data The existing aerial survey (1981, 2foot contour) was available from the east side of Clear Creek County to approximately one mile east of Copper Mountain Ski area. The remainder of the corridor was modeled using USGS mapping. The aerial survey mapping provided 2-foot contour accuracy for a band approximately 200-feet wide. The USGS mapping has an accuracy of +/- 40 feet. To supplement this data, a car mounted global positioning satellite (GPS) unit was used to map the pavement along the corridor from C- 70 o Avon. This survey gave the designers the general alignment of the highway in both directions (which, by analytic comparisons gave the median widths) and it created a profile for the existing I-70 roadway from C-470 to Avon. This information was then incorporated into the digital terrain models that had been oreviously complete

existing I-70 roadway alignment. This allowed easy access for track maintenance and called for less impact to the surrounding land (right-of-way required etc.).

Representative sections were used to generalize segments of the corridor in developing the 6% and 7% (highway) grade alignments. In determining the representative section required at locations throughout the corridor, the horizontal alignment of the FGT first had to be determined. In areas where an aerial survey was available, the median was graphically measured to determine if the FGT could be built in the median. In areas where only USGS mapping was available, the median was visually inspected using aerial photos and then was field verified to determine if the FGT could be built in the median. If in the median, the FGT was placed immediately adjacent to the upper section of roadway. This was done to allow snow to be plowed from the FGT section into the median (if room was available). If building the FGT in the median was not feasible, the north and south sides of the roadway were evaluated to determine the ideal location of the FGT. The location was chosen based on the following criteria: space available, shadowing, existing terrain (including proximity to water courses),



location of highway access points, potential locations for stations/platforms, and connection to alignments done by others (at the Clear Creek County lines and in Dowd Canyon).

Once the horizontal location was determined, the vertical location was determined (elevated or on grade). This was done based on the elevation at that location (greater/less than 8000') and the surrounding terrain (flat/steep etc).

Upon the determination of the location (horizontal and vertical), the representative section was chosen

Special Alignment Studies - CIFGA

The character of the technology proposed by CIFGA in 2001 (the ability to operate at grades at or above 10%) created several special study cases within the corridor. In general, the CIFGA technology was assumed to follow the highway (7%) alignment alternative. The special studies were completed based on comments/recommendations from members of the CIFGA organization.

Kermit's Alignment - The one deviation that was studied to the greatest detail was an alignment that departed the existing I-70 roadway at the bottom of Floyd Hill, went over Kermit's Bar and Grill on US6 and stayed north of I-70 until rejoining I-70 between the twin tunnels and Idaho Springs. The grades for the CIFGA alignment were not limited and therefore provided more flexibility in the location of the horizontal and vertical alignments. This alternative was developed to the point of having a preliminary horizontal and vertical alignment, which was provided as input to the Train Performance Calculator. The goal of this study was to see what differences there were in overall travel time due to the alternative alignment. The results show only minor time savings (minutes over the entire trip length of greater than 1.2 hours). The summary of these RailSim studies can be found in the appendix (Interstate 70 7% CIFGA Monorail Summary & Interstate 70 7% Kermit CIFGA Monorail Summary).

Continental Divide Alignment - The second significant deviation for CIFGA was based on the suggestion to go over the Continental Divide. This alternative was not studied further based on anticipated environmental impacts and the Forest Service's unlikely approval of any alignment in that area.

Snake Creek Alignment - This was a deviation of the 6% alignment that was primarily driven by CIFGA's desire to use the original pioneer bore from the Eisenhower tunnel locations studies and to capture the potential ridership from the Keystone resort area. Two sub-alternatives were looked at to get around the Dillon Reservoir, one south and one east. These alternatives were only sketched on USGS maps and were not taken to the level of detail of the main 6% alignment. A map showing the Snake Creek Alignment can be found in the appendix.

From alignment description report, Sept. 2002

to best fit the conditions of the alignment segment. Three basic sections were used in the development of the alignments: structured on-grade and bridged. Within each of these sections there are variations such as whether the section requires a retaining wall, is adjacent to the roadway or slightly detached, or whether the section is benched into an adjacent hillside or on structure.

Cross sections were developed based on the logic described above. The toes of slope were generated and drawn on corridor mapping as an impact area. This process also created construction impacts for the alternative. Fifteen feet of width outside of the toe of slope on the side of the FGT template not bordering the

roadway was added to account for construction activities. This was only applied to sections that were not in the median. It was assumed that if the FGT alternatives were in the median, the construction will be completed within the bordering roadway.

A summary of the representative sections for the FGT alternatives can be found in the appendix of this report.

Rail Transit Technology - 6% v 7% grades

As described above, in identifying the 6% alignment it was found necessary to deviate from the current alignment of I-70 for extended distances. In addition, extensive tunneling was required. These undesirable conditions led the Project Team to question the necessity for this alignment. In essence,



the Team asked TranSystems to analyze the feasibility of creating a single Rail Transit mode that combines the performance characteristics of Electric Light Rail with the capacity and operational characteristics of Heavy Rail. During the evaluation of Heavy Rail Rapid Transit and Light Rail Transit systems, it was noted that many systems were operating on extreme gradients. A number of rail routes in Switzerland (MOB, GFM, and RhB) run passenger trains on grades up to 7% for short distances (without rack assists), and historical systems that ran in San Francisco and Seattle with grades in the 7% to 12% range. Upon review of the rail transit design guidebooks compiled by the American Public Transportation Association and the Transportation Research Board, it was concluded that operation on the I-70 highway gradient would be feasible with suitable equipment. See the "Summary of Modes Tested" section for a description.

Conventional Monorail Technology

The rubber-tired Hitachi monorail train now being utilized in this study can readily handle 6% grades. Grades 7-8% require heating of the beam for ice melting to maintain adhesion for traction and braking. Typical sections were developed specifically for monorail. One specific design criterion adopted was to always place the beam high enough so that trains would run, at least, five feet off the ground, eliminating the need to perform most snow removal.

Urban Maglev Technology

This is the technology currently under consideration by CIFGA. Most maglev research has been focused on high-speed, long distance lines so relatively little information is available. The same alignment as Conventional Monorail was used.

Bus Alternatives

The two diesel bus alternatives (transitway and guideway) have also been redefined to have construction of the facility only between the east side of Eisenhower/Johnson Tunnels and Hyland Hills, the current end of the six-lane configuration of I-70. Currently, congestion rarely occurs east of this point. These alternatives are now designated as the Truncated Diesel Bus-in-Guideway and Truncated Diesel Bus-in-Transitway. The Dual Mode Bus-in-Guideway continues to be considered as being built westbound from Jefferson, and terminating westbound at the east side of the continental divide tunnel with the eastbound originating at Silverthorne. This arrangement allows the dual-mode buses to have access to electric power to climb the approach to the west portal of the continental divide tunnel and Floyd Hill under electric power (to achieve higher speeds and lower noise levels). The final alternative modification was to consolidate the two remaining rail alternatives as Rail Transit alternative, operating in the same "highway" alignment as the other transit alternatives.

Assumptions

In all cases the FGT was assumed to be barrier separated from the existing roadway. Options that located the alignment away from the roadway by more than 100 feet, assumed a 15-foot service road near the FGT alignment in the locations where the separation occurred. If the alignment was



bordering the existing roadway, it was assumed that the existing roadway would serve as the maintenance access, eliminating the need for an additional maintenance roadway. Anytime the FGT was immediately adjacent to the roadway and above 8000 feet in elevation, the section was elevated to allow for the management of snow. (For a complete explanation of snow removal/storage, see the Snow Removal Report appendix).

Conclusions

Because of the level of detailed survey information, the alignments studied are conceptual in nature. Modifications may be needed as the project progresses. These modifications may include slight changes in grade or in horizontal alignment to accommodate operational conditions (single track versus double track, station location, etc.) and identified environmental constraints not known at this time. The impacts shown in the alignment files are as accurate as the base maps that were used to create the cross sections. Upon receipt of more accurate data, the location of stations in the corridor and other features for the transit alternative alignments can be modified to reflect these changes.



TRAIN PERFORMANCE CALCULATOR

The Railsim 7® Train Performance Calculator (TPC) was utilized to model train performance of the three FGT and three RTT alternatives. This particular Train Performance Calculator has gained recognition within the industry as one of the most comprehensive simulators used today. The Norfolk Southern Railway uses Railsim 7® for use exclusive as a planning and costing tool. Railsim 7® was also used for a major capacity study of the congested segment of the Northeast Corridor between Newark, NJ and Penn Station, New York City.

The TPC was used to project performance characteristics of all of the types of equipment selected in Level 2 screening over the proposed FGT alignment from C-470 to Vail. In this phase of the study the only alignment tested was the "Highway" alignment, so the grades and curves of the existing I-70 roadway were input using the TPC's Database Editor. The TPC was used as a planning tool to:

- Develop trip time predictions for the FGT alignments (required to calculate operating costs and fleet size requirement analyses, a key part of capital costs)
- Predict energy consumption (kWh for electrically-powered trains and gallons for dieselpowered bus; kWh was also an input for sizing the electrical distribution system).

In summary, the TPC was used to generate detailed and highly accurate performance characteristics of trains and buses operating over a specified alignment. The performance data includes time, distance, velocity and acceleration on grades, among the many types of output.

The TPC Report Generator function summarizes performance from the raw output files (numerous data points are recorded each second of the simulated run, typically one to two hours long). To date, text-based Train Summary Reports have been produced for each run. The report provides an overview of the selected TPC run(s), by station. It includes a header identifying the report and the geographic limits of the run, as well as all option and parameter settings, station arrive and leave or pass times (for express runs) based on cumulative running time from the beginning of the run, as well as distance operated, average velocity (with and without station stops), peak power demand and energy consumption for and End to End run. The TPC can also produce user-specified graphic plot reports.

Summary of Transit Modes Tested

Railsim 7® has an extensive library of rail equipment. There are 344 North American Locomotives, 128 North American Coaches, 64 North American Multiple Unit Cars, 220 North American Transit Vehicles, 292 World Wide Multiple Unit Cars, and 412 World Wide Transit Vehicles. With this roster to choose from, it was possible to select the best type of equipment available as a starting point for creation of custom-built train sets utilizing the capability of the TPC to build "user-defined" rolling stock to meet the specific needs of the corridor, most notably the grades up to 7%. The same approach was used to simulate the non-rail systems (monorail and urban maglev) and buses (both diesel and dual mode). It was also possible to define these as TPC rolling stock types, with appropriate

characteristics.

The terminals and stop patterns set in the TPC runs were those established as part of the overall study, and as refined in the development of the operating plan.

The characteristics of each mode were described in an earlier section (Summary of Transit Modes Tested, p.1). The following section provides mode-specific parameters input in TPC and the resulting average speeds and energy usage.

RTT Alternatives

Both a Diesel and Dual Mode bus were modeled from user defined vehicles and were built to simulate buses, primarily to estimate electricity consumption, to allow sizing an electric power distribution system for trolleybuses and dual mode buses. Diesel fuel requirements were also calculated using Railsim. Railsim's rubber-tired vehicle resistance coefficient was used for the bus runs. Only the segment on the Transitway/Guideway was tested in the TPC. Stop patterns utilized were those established in the Operating Plan. Separate runs were conducted the three bus alternatives for each of the four stop patterns in both directions. Running time and distance for the segments off I-70 were calculated using DeLorme software. For the two Truncated Diesel Bus alternatives, JF Sato provided running time for the section of I-70 between Jefferson and Hyland Hills. Energy requirements were estimated for the sections not modeled in the TPC based on mileage of proposed buses since all buses would run on gasoline this section.

Diesel Bus, Transitway and Guideway

When in the Transitway, the maximum speed was set at 65mph, which is the maximum posted speed on this portion of I-70. It was assumed that the Transitway would be built with standard highway superelevation and speed on curves was set appropriately. The Diesel bus in transitway had an average speed of 43.9 mph for the portion of the routes on I-70 averaged for the two directions. Diesel buses on Guideway were tested with a maximum speed of 70 mph, because the Guideway would keep buses on the alignment. This bus had an average speed of 49.2 mph.

Dual Mode Bus on Guideway

Top speed on the Guideway was set at 75mph. Some adjustment were made to the running time calculated by Delorme for the segments off I-70 to account for operating the heavy dual mode buses on diesel power on heavy grades on Berthoud Pass (*en route* to Winter Park and Vail Pass). Simulation showed travel on I-70 at an average speed of 54.9 mph.

Rail Transit

Top speed was set at 80 mph as curvature would not allow higher speeds virtually anywhere in the corridor. TPC runs were conducted with twelve inches maximum superelevation and six inches of cant deficiency. In some sections with steep downgrades it was necessary to test with civil speed limits imposed to prevent trains from running away. Station dwell time was assumed to be 45 seconds at each station (2 minutes at Denver Union Station). In order to collect all the running time and energy consumption data required to complete operating and capital cost estimates, TPC runs were conducted



(in both directions) between:

- Denver International Airport (DIA) and Vail
- DIA and Frisco
- Jefferson Station (US 6/C-470) and Vail
- Jefferson Station and Frisco.

The ten car EMU R2 train performed at an average speed of 52.3 mph (on the Jefferson-Vail run, averaged for the two directions). The run time between (DIA) and Vail was 2 hours 37 minutes, using 8237 kWh of electricity westbound and 5898 eastbound.

Conventional Monorail

Top speed is limited to 60 mph by the use of large rubber tires. The RailSim 7 "rubber tire" friction coefficient was used. Acceptable cant deficiency was set at 6 inches. The same stop pattern and station dwell time was used as for rail transit. Its average speed was 42.5 mph with a maximum speed of 60 mph an elapsed time of 2:42. For the westbound DIA to Vail trip, the monorail used 4133 kWh and 2323 kWh for the eastbound trip.

Urban Maglev

Since this is a new mode, no empirical data exists from existing systems. Most of the data entered into the TPC was provided by CIFGA, including a 100 mph top speed, to reflect lack of friction resistance. Those included: rolling resistance, journal, and flange resistance. Again, the same stop pattern and station dwell time was used as for rail transit. The Urban Maglev operated at an average speed of 61.5 mph when traveling between DIA and Vail with an end-to-end running time of 2:10, including dwell time.



OPERATING PLAN

This section describes the assumptions regarding the alignments and operating parameters that were made for each mode. A sketch-operating plan was developed for each modal alternative. This was a two-phase effort.

In the first phase JF Sato used their travel demand forecasting model to develop Year 2020 ridership estimates, by time of day and by station, for a single day type – winter Saturday, the heaviest day of travel – based on three different assumptions of average fares; 5ϕ , 10ϕ and 25ϕ per mile. In this phase three operating plans were developed for each mode (one designed to serve the ridership associated with each fare level), but only for this day type. The result was a schedule of headways at various times of day. With this it was possible to calculate the number of vehicle miles and crew hours. Other components, such as station agents and dispatching were also identified. Operating costs were calculated using these factors. Results are presented in Table X. The Project Team determined that, of these, the 10ϕ per mile level provided the best balance between attracting enough riders to make a significant contribution toward reducing congestion and recovering a substantial portion of operating costs; some modes had an operating surplus, which would be available to cover deficits on other, lighter travel days. The model of seeking to cover a given portion of operating costs, and not focus on capital costs for making this decision, is similar to the approach used on highway construction projects where vehicle operating costs are not considered.

In the second phase, JF Sato utilized average speeds and travel times developed by TranSystems in the first phase as inputs to the travel demand forecasting model to develop ridership levels for each mode for each of the seven representative day types. TranSystems then established appropriate operating plans for each mode for each of the typical day types. JF Sato also provided a calendar which established how many days of each of the seven day types would occur over the year. The result was that TranSystems was able to establish total annual operating costs for each mode. Capital costs for building the infrastructure (including maintenance facilities) and purchase of vehicles could also be derived from the sketch operating plans.

The I-70 PEIS covers the corridor from the intersection of I-70/US 6/C-470 west to Vail. Capital cost estimates have focused on construction of infrastructure in this corridor. However, for the purpose of designing and calculating operating costs the FGT/RTT service, it has been assumed that service would run through to the Denver Metro area, although over undefined routes. The FGT modes would operate to downtown and DIA.

RTT Alternatives Descriptions

All of the bus alternatives were based on the same route structure. These involve origins at four points in the Denver Metro area (downtown, DIA, south and north) and various terminals on the west end. For simplicity, all routes were assumed to operate all day long, everyday. See Summary of Transit Modes Tested for a description of the technologies.

Route	Frequency- Am Peak (Winter Sat) (in minutes)	Frequency- Am Peak (Low Weekday) (in minutes)	Number of Stops
Route 1: Westminster to Central City	15	12	6: Westminster, Arvada, Ward Rd, Jefferson, U.S. 6, Casinos
Route 2: Tech Center Winter Park	6	4	5: Tech Center, Mineral Springs, Jefferson, Empire, Winter Park
Route 3: Tech Center Arapahoe Basin	6	10	6: Tech Center, Mineral Springs, Jefferson, Silverthome, Keystone, Arapahoe Basin
Route 4: Westminster Breckenridge	4	6	6: Westminster, Arvada, Ward Rd, Frisco, Breckenridge
Route 5: DIA-Vali	6	10	7: DIA, Pena, Stapleton, Jefferson, Frisco, Copper Mountain, Vail
Route 6: Denver Union Station-Glenwood Springs	4	10	3 in Corridor and 8 West of Vail: DUS, Jefferson, Frisco, Vail, Edwards, Wolcott, Eagle Village, Eagle Airport, Gypsum, Dotsero, Glenwood Springs
Route 7: Denver Union Station – Frisco Locai	8	7	10: DUS, Cold Spring, Jefferson, El Rancho, US 6, Idaho Springs, Empire, Georgetown, Loveland, Silverthome, Frisco

Diesel bus in transitway:

This alternative travels in a transitway from either Jefferson to the east portal of the continental divide tunnel or with a transit way for only Jefferson to the Clear Creek County line and then enters into mixed traffic between the Clear Creek County line (Floyd Hill) and the eastern portal of the Eisenhower/Johnson Tunnel. It was assumed that the Transitway would end at the west side of the Eisenhower/Johnson Tunnel. A transitway refers to a limited access roadway designated for the exclusive use of transit vehicles or other designated vehicles. Several aspects of transitways are both strengths and weaknesses. For example, transitways are not necessarily vehicle specific and consequently emergency vehicles may use it. Existing bus transitway systems are located in Pittsburgh and Ottawa (Canada).

Diesel bus in guideway:

A guideway refers to a transit facility which uses buses equipped with horizontal guidewheels which run tightly against a vertical beam or the edge of the roadway. Such specialized facilities cannot be utilized by other vehicles. Guideways may operate at higher speeds than transitways because vehicles are mechanically guided. The only high speed bus guideway system is the O-Bahn in Adelaide, Australia. TranSystems conducted a comprehensive site visit to this system and found it to be a very appropriate model for the I-70 corridor. A written technical report and a video were provided to CDOT.

Dual mode in Guideway

The Dual mode bus in guideway option uses an articulated bus powered by electricity in the guideway and diesel off the guideway. This option has the advantage of providing electric power to quickly and quietly climb mountain grades. This alternative assumes that a single direction Continental Divide tunnel would be provided for use in the peak direction for the buses. The arrangement for inserting reverse-peak direction buses at the front of the Tunnel queue described above would be also be



applied.

Rail Transit

Station stops were assumed at: Vail, Copper Mountain, Frisco, Silverthorne, Loveland, Georgetown, Empire, Idaho Springs, US 6, El Rancho, Jefferson, Denver Union Station and Denver International Airport. Because the same general technology has already been selected as the Locally Preferred Alternative for routes in the Denver area this should not be a problem. At this point in the analysis, it was assumed that sufficient capacity would exist for the Intermountain Corridor trains. Because preliminary ridership estimates showed high levels of ridership, with resulting frequent service, a skip stop operating plan was assumed in the corridor. Even with only half of the trains stopping, intermediate stops would have quite frequent service, while all passengers would benefit from faster service. The ridership projections provided by JF Sato indicated that that is a significant drop-off in ridership west of Frisco. Therefore, it is proposed to terminate a significant number of trains at Frisco. This, in turn, would allow construction of the line west of Frisco with a single track. Two, two-mile long passing tracks would enable the operation of trains with no delay if they are close to schedule. A single track Continental Divide tunnel is also proposed; this will be relatively short and should cause very little delay.

Conventional Monorail

The same station stops and station dwell time as the rail transit alternative were assumed. While the operating plan assumed that trains would operate through to downtown Denver and DIA, this is not the same technology Denver has selected as the Locally Preferred Alternative; there may be a need to transfer between the Mountain Corridor system and RTD lines at Jefferson (US 6/C-470). Because of the smaller capacity of monorail trains, more frequent service is required. Therefore, single guideway alternatives are not feasible west of Frisco. However, for the short distance involved, this approach is feasible for the Continental Divide Tunnel. TranSystems also conducted a comprehensive site visit to monorail in Japan. Again, safe, reliable service is provided, although capital costs are high. A technical report was provided to CDOT.

Urban Maglev

Again, the same station stops and dwell times were assumed for the Urban Maglev and a wide Rail Transit alternative. Similar to the Conventional Monorail, the Urban Maglev is not the technology adopted by the Locally Preferred Alternative for RTD. While it has been assumed that passengers will be able to ride through to Metro Denver points; there may still be a need to transfer between the Mountain Corridor system and RTD lines at Jefferson (US 6/C-470).

Summary of Operating Costs

As described in the Operating Plan section, operating costs were computed for the sketch operating plans for each modal alternative for the seven different day types: a winter Thursday, winter Saturday, winter Sunday, summer Thursday, summer Saturday, summer Sunday, and low ridership weekday. Annual system operating costs were developed based on the calendar provided by JF Sato which identified how many days of each type would need to be operated.



The operating plans allowed calculation of the number of vehicle miles operated, fuel or power consumed, crew hours, as well as hours for station staff, dispatch staff, management and support staff, and casualty and liability costs. This section describes how costs were applied to these elements. All costs were calculated at constant 2002 levels, without inflation.

Vehicle Mile Cost

Vehicle Mile Cost represents the cost per vehicle mile, not including fuel. This essentially represents an assignment of costs for vehicle maintenance and cleaning. When comparing trains to buses it is important to consider that each car of train is a unit; whereas, a bus is only one unit. This component essentially represents an assignment of costs for vehicle maintenance and cleaning. In this system different modes were assigned different costs:

Alternative	Vehicle Mile Cost	Per Seat Mile
Diesel Bus in Transitway (Truncated)	\$0.79	\$0.017
Diesel Bus in Guideway (Truncated)	\$0.79	\$0.017
Dual Mode Bus in Guideway	\$0.91	\$0.013
Heavy Rail	\$1.10	\$0.018
Conventional Monorail	\$8.58 (train)	\$0.024
Urban Maglev	\$9.90 (train)	\$0.026

Fuel or Power Consumed

The total fuel or electric power consumed was determined differently for rail, monorail, and urban maglev than it was for the buses. For rail, monorail and urban maglev the TPC simulation output provided the power consumed for the entire length of each trip in each direction. A price of \$0.10 per Kwh was assigned.

The Diesel Bus fuel quantity was the sum of two calculations. One set of simulations was done using the TPC to determine the amount of fuel used in the transitway or guideway portion. This sum was added to a figure representing service on I-70 east and west of the transitway or guideway. This was added to a third quantity for service extending out of the I-70 corridor. The Diesel Bus mileage from the Railsim output was applied to the distance of the bus routes outside the I-70. A cost of \$1.60 per gallon was assumed for diesel fuel. The Dual Mode Bus alternative combined electric power used in the guideway with the fuel used in diesel mode off the guideway.

Crew Person Hours

Crew person hours represent the total hours required to crew the vehicles. Crew members operate vehicles, participate in fare collection/inspection activities and assist in emergencies (a decision was made early in the I-70 PEIS process that no unmanned, automated systems would be appropriate for operation in this long corridor, much of which is located in remote areas.) This is based on the total amount of time the vehicles require to make the round trip plus an allowance of an additional 15% to cover schedule recovery time and administrative time (checkin/checkout, etc.). Buses had one person (the driver); whereas, the crew for rail, monorail, and urban maglev varied. For rail, two (an operator and a conductor) were assigned to five car trains and three (add an assistant conductor) were assigned



to ten car trains. For the relatively short monorail two crew members (an operator and a conductor) were assigned and three crew members were assigned for urban maglev. Since the maglev has two large cars it was necessary to assign a conductor to each car in addition to the operator. No food service staff costs (or revenue) were calculated because it was assumed that food/beverage service would be self-supporting. Crew person costs were calculated based on a \$16.00/hour wage and fringe benefits of 60%.

Other Labor Costs

Labor Cost includes the crew, station staff, dispatch staff, management, and other support staff. Maintenance labor is accounted for in the Vehicle Mile Cost, above. Similarly fare collection related labor is accounted for both station staff and in the management staff.

Station and Dispatch staff and Management staff were calculated as follows:

- Station Staff: \$16.00 per hour with an additional 60% for fringe benefits (\$25.60)
- Dispatch Staff: \$19.20 per hour with an additional 60% for fringe benefits (\$30.72)
- Management: \$24.00 per hour with an additional 60% for fringe benefits (\$38.40)

Station staffing was tailored to meet the needs of the station. Those needs were a function of the station usage provided by Sato's travel demand forecast. In conjunction with the ridership, station staff was also a function of location on the system. Once labor requirements were determined for each location they were held constant throughout the operations analysis. Thus it is necessary that these locations be staffed the same way for all modes evaluated.

Station	Staffing	Station	Staffing
VAIL	7	IDAHO SPRINGS	0
COPPER MTN	5	US-6	0
FRISCO	7	EL RANCH0	3
SILVERTHORNE	5	JEFFERSON	3
LOVELAND	5	ARVADA	3
GEORGETOWN	0	UNION STATION	17
EMPIRE JNCT	3	AIRPORT	5
Subtotal	32	Subtotal	31
	Total	63	

Casualty and Liability Costs

Casualty costs and liability costs were computed to represent the total cost of liabilities and casualties relating to vehicle operations, vehicle maintenance, non-vehicle maintenance, general administration, administration and support, ticketing and fare collection, system security and the total modal expense. Costs for the I-70 transit alternatives were estimated based on data on the directly operated transit included in the National Transit Database 2000.

Alternatives	Vehicle Miles Operated	Liability and Casualty Cost



58,063,000.00	\$	3,226,000.00
49,588,000.00	\$	2,754,900.00
33,720,000.00	\$	1,873,400.00
37,456,000.00	\$	5,525,000.00
7,056,000.00	\$	8,879,000.00
6,672,000.00	\$	11,994,600.00
	49,588,000.00 33,720,000.00 37,456,000.00 7,056,000.00	49,588,000.00 \$ 33,720,000.00 \$ 37,456,000.00 \$ 7,056,000.00 \$

All the transit alternative's Liability and Casualty Costs were derived from linear regressions of the Casualty & Liability Costs/Total Modal Expense category as the independent variable and Total Actual Vehicle miles as a dependent variable controlled for the mode studied. Linear Regressions were done with outliers excluded and correlation of 0.9 to 1. Bus costs were derived from linear regressions from the data controlled for buses. Similarly Rail Transit costs were derived from linear regression of the Casualty & Liability Costs/Total Modal Expense category controlling for all rail modes (commuter, heavy, and light rail). Monorail costs were derived also from linear regression for all rail modes but the data were weighted for monorail. Lastly, Urban Maglev costs were derived from the monorail cost with a factor of 1.35 miles applied to represent additional costs associated with new technology.



CAPITAL COST ESTIMATES

Six capital cost alternatives were developed for transit in the I-70 Mountain Corridor. They are as follows:

Alternative	Width (ft)	Location
Truncated Bus-in-Transitway	36	Hyland Hills to East Side of Eisenhower/Johnson Tunnel
Truncated Bus-in-Guideway	24	Hyland Hills to East Side of Eisenhower/Johnson Tunnel
Dual Mode Bus-in-Guideway	24	Jefferson Station to Silverthorne (WB to Eisenhower/Johnson Tunnel)
Rail Transit	34	Jefferson Station to Vail
Conventional Monorail	34	Jefferson Station to Vail
Urban Maglev	34	Jefferson Station to Vail

Each of these alternatives had been previously developed to the point that the representative sections were chosen for the length of the alignment. Therefore it had been previously determined if the alternative was on structure or on grade or on the north, south or median of the roadway. Quantities were determined based on this information. See appendix for quantity summaries.

Elements of Capital Cost Estimate

Quantities were calculated using both a computer model (where data was available) and GPS data in combination with USGS mapping. Each alternative was then utilized to develop quantities for grading, bridges, retaining walls, track (for rail), beamway (monorail, maglev), roadway /guideway (for buses), electrification (for all modes except diesel bus), maintenance facilities & equipment, and rolling stock. Each of these quantities were then broken down by segment so a cost per segment could be calculated. In Clear Creek County, JF Sato provided the quantities for grading, bridges, asphalt (as appropriate) and TranSystems quantified electrification, track/beamway/guideway, and maintenance for this section.

Truncated Bus-in-Transitway

The truncated bus-in-transitway ran from the Hyland Hills Interchange to the east side of the Eisenhower/Johnson Tunnel. This alternative was be very similar to a roadway in that the buses would operate within a standard width roadway that is constructed of asphalt and will be separated from traffic with concrete barriers. This entire option falls within Clear Creek County. As a result, TranSystems calculated costs for maintenance, rolling stock and electrification. JF Sato calculated the quantities such as bridge, structure, earthwork and other transitway costs as required.

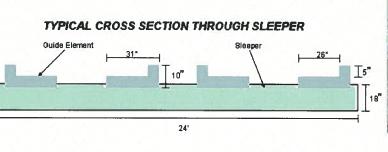
Truncated Bus-in-Guideway

The diesel bus-in-guideway option began at Hyland Hills Interchange and ran to the east side of the Eisenhower/Johnson Tunnel. This alternative had two variations for the guideway systems within the alternative. The first option is a single guideway that has the trackway and the guide beam all in one.



The second option is similar to an existing system in Adelaide, Australia (see photograph below). This systems has sleepers and guide elements that are placed separately (as shown below). The difference between the existing system in Australia and this project is that I-70 systems, the soil and existing ground conditions are much more stable and therefore would not require caissons to be drilled to act as a foundation for the sleepers. For the I-70 Mountain Corridor, it was assumed that the soil conditions would allow base course material to be relied upon eliminating the need for pilings.

This entire option falls within Clear Creek County. As a result, TranSystems calculated costs for maintenance, rolling stock, guide elements and electrification. JF Sato calculated the quantities such as bridge, structure, earthwork and other guideway costs as required.





Guided Bus system in Adelaide, Australia

Dual Mode Bus-in-Guideway

The dual mode bus-in-guideway began at Jefferson station and ended in Silverthorne. This option was bi-directional from Jefferson station to the east side of the Continental Divide Tunnel, peak direction through the tunnel and eastbound only from Silverthorne to the west portal of the Tunnel.

This option falls in Jefferson County, Clear Creek County and in Summit County. JF Sato calculated the costs for earthwork, structure, bridge and base course for the portion of the alignment that falls in Clear Creek County. TranSystems calculated guideway costs, maintenance, rolling stock and electrification within Clear Creek County and all costs outside of Clear Creek County.

Rail Transit

The rail transit option also began at the Jefferson station and continued along the I-70 roadway to Vail. This alternative varies between single and double track depending on its location in the corridor. A single-track section was used to get through the Continental Divide Tunnel due to geologic issues as well as cost considerations. A single-track section, with passing sidings, was also used from approximately Frisco west to Vail. The following chart summarizes single and double track locations:



Segment	Double Track	Single Track
Jefferson Station - Hyland Hills	X	
Hyland Hills - Empire Junction/US 40	X	
Empire Junction/US 40 - Loveland/US 6	X	
Loveland/US 6 - East Side of Tunnel	X	
Eisenhower/Johnson Tunnel		X
West Side of Tunnel – Frisco	X	
Frisco – Vail		X

This option falls in Jefferson County, Clear Creek County, Summit County and Eagle County. JF Sato calculated the costs for earthwork, structure, bridge and base course for the portion of the alignment that falls in Clear Creek County. TranSystems calculated guideway costs, maintenance, rolling stock and electrification within Clear Creek County and all costs outside of Clear Creek County. This included rail structure/trackwork, signals, stations, fare collection interlockings and general maintenance costs. JF Sato calculated the tunnel costs for this option..

Monorail

The Monorail option began at the Jefferson station and generally continued along the I-70 roadway through Vail. It was assumed that the Monorail would be dual direction for the entire length of the alternative, except for the tunnel. The representative cross sections for this option can be found in the appendix.

Capital Costs for Monorail – General cost of the structure was first calculated. This was done anywhere that the alignment was elevated on structure adjacent to the roadway. This cost included caissons, pier bents and running beams. The second cost calculated for the Monorail was the guideway structure. This item included running rails and power rails. Earthwork and retaining walls were also found based on the representative section that was used. The last cost for the Monorail was a general engineering cost. This included costs for highway reconstruction where needed to accommodate for the Monorail, fencing costs for the Monorail structure and a cost for utilities.

Urban Magnetic Levitation

The Urban Maglev option began at the Jefferson station and generally continued along the I-70 roadway to Vail. It was assumed that the Maglev would be dual direction for the entire length of the alternative, except though the Continental Divide Tunnel. The representative cross sections for this option can be found in the appendix.

Capital Costs for Maglev – General cost of the structure was first calculated. This was done anywhere that the alignment was elevated on structure adjacent to the roadway. This cost included caissons, pier bents and running beams. The second cost calculated for the Maglev was the guideway structure. This item included running rails and power rails. Earthwork and retaining walls were also found based on the representative section that was used. The last cost for the Maglev was a general

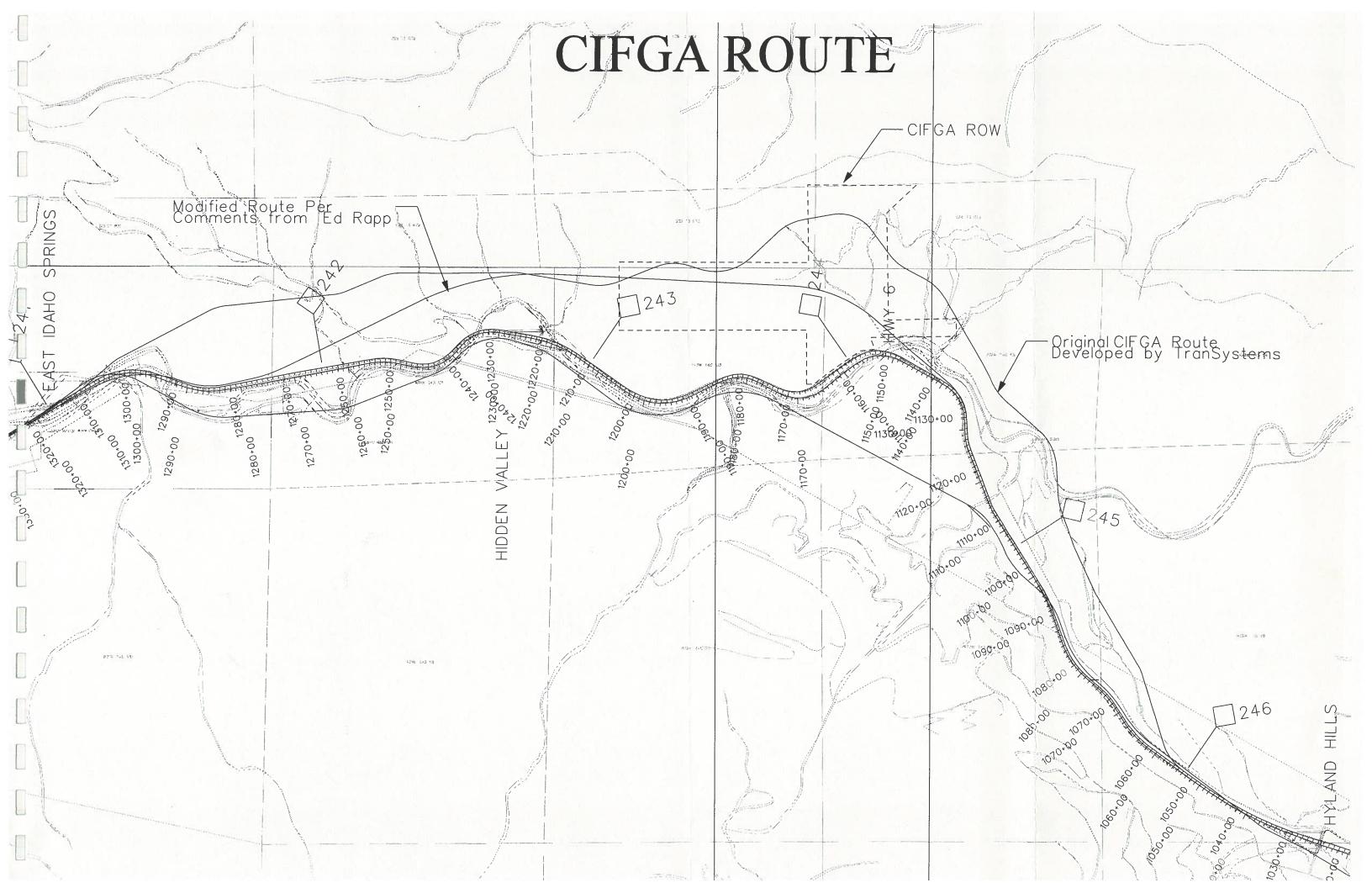


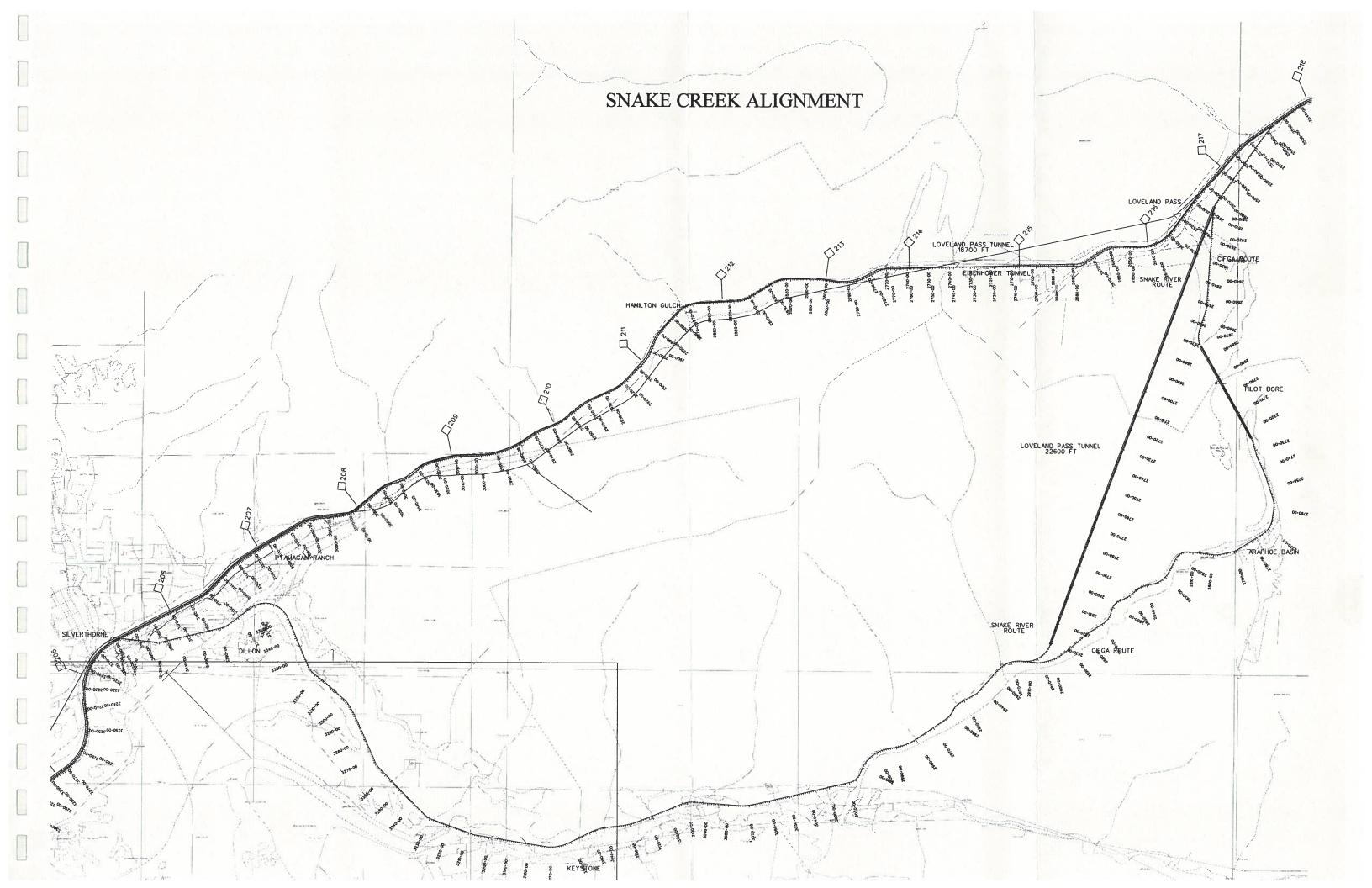
engineering cost. This included costs for highway reconstruction where needed to accommodate for the Maglev, fencing costs for the Maglev structure and a cost for utilities.

Summary of Capital Cost Estimate

Technology	Construction items Cost	Contingencies Cost ^e	Total Cost	Segment Length	Notes
Bus in	CUSI	COSt	COST		
Guideway	\$244,605,320	\$431,374,392	\$675,979,712	30.65 miles	Does not include structure, walls, basecourse, earthwork or tunnels
Bus in				-	
Transitway	\$185,283,000	\$326,756,349	\$512,039,349	30.65 miles	Does not include structure, walls, basecourse, earthwork, asphalt, conc. Barrier or tunnels
Heavy Rail	\$2,209,550,130	\$3,896,658,275	\$6,106,208,405	86.8 miles	Does not include basecourse, earthwork, walls or stuctures in Clear Creek County
Monorail	\$2,453,048,160	\$4,252,984,818	\$6,706,032,976	86.8 miles	Does not include basecourse, earthwork, walls or stuctures in Clear Creek County
Maglev	\$2,543,253,160	\$4,485,161,182	\$7,028,414,342	86.8 miles	Does not include basecourse, earthwork, walls or stuctures in Clear Creek County

*Contingency factors as given to TranSystems by JF Sato See appendix for complete cost breakdown





Interstate 70 7% Kermit CIFGA Monorail Summary

Inclored to 1 % retring on on monoral outputs			מוץ										
Station	Event	Interval Time	Time Elapsed Time		Distance	Average Spd.	l. Max.	Max. Spd. M	ake Up	Peak Po	wer F	Make Up Peak Power Power Consumption	otion
Ō	State	Hrs:Min	Hrs:Min	-	Feet	Mph	Mph	ď	Percent	kw	×	kwh	
6TH AVE WEST	Departure		0:00	00:0	0			Ż	N.A.				0
GOLDEN / C-470	Arrival		0:02	0:02	10495.37	54.5	5	94.43	0	74	7494.9		137.3
GOLDEN / C-470	Departure		0:01	0:03	0	40.59	6		0		0		0
ELRANCHO / EVERGREEN	Arrival		0:07	0:10	39797.68	65.99	6	100	0	74	7489.5	4	447.52
ELRANCHO / EVERGREEN	Departure		0:01	0:11	0	59.48	œ		0		0		0
IDAHO SPRINGS	Arrival		0:10	0:20	64200.29	75.78	ø	99.51	0	750	509.16	2	508.86
IDAHO SPRINGS	Departure		0:01	0:21	0	70.31			0		0		0
EMPIRE	Arrival		0:05	0:26	38000.48	80.19	0	100	0	749	496.91	e	300.08
EMPIRE	Departure		0:01	0:27	0	70.39	ő		0		0		0
GEORGETOWN	Arrival		0:03	0:30	21997.44	75.63	ŝ	100	0	749	7497.87	-	171.61
GEORGETOWN	Departure		0:01	0:31	0	61.65	5 2		0		0		0
LOVELAND	Arrival		0:08	0:39	66007.67	89.49	ō.	100	0	750	7504.59	2	705.95
LOVELAND	Departure		0:01	0:40	0	82.14	4		0		0		0
ILVERTHORNE / DILLON	Arrival		0:07	0:47	51999.96	83.29	-	100.01	0	72	7495.5	~	123.42
ILVERTHORNE / DILLON	Departure		0:01	0:48	0	75.32	2		0		0		0
FRISCO	Arrival		0:04	0:52	24696.11	79.88		100.01	0	75(7509.01	-	182.44
FRISCO	Departure		0:01	0:52	0	65.83	ñ		0		0		0
COPPER MOUNTAIN	Arrival		0:04	0:57	33197.47	84.55	5	100	0	7	7505.2	2	251.08
COPPER MOUNTAIN	Departure		0:01	0:58	0	72.38	80		0		0		0
VAIL	Arrival		0:14	1:12	113402.96	90.62	2	10 1	0	749	491.09	en	365.11
Run Total (With Dwells)			1:12		463795.43	73.42	ľ	100.01	0		509.16	31	3193.37
Run Total (Without Dwells)			1:05		463795.43	81.05	`	100.01 N.A	¥.	75(7509.16	31	3193.37

Interstate 70 7% CIFGA Monorail Summary

				L L		C C C C C C C C C C C C C C C C C C C	A Mar			1 2000			
oration	Event	Interval lime	illie Elapsed Lillie	alline i	DISIANCE	Average opu. Iviax. opu.	DU. Max		Make up		IDMOL	Lear Lower Lower Consumption	-
Q	State	Hrs:Min	Hrs:Min		Feet	Mph	Mph		Percent	٨		kwh	
6TH AVE WEST	Departure	0	0:00	00:0	0				N.A.				0
GOLDEN / C-470	Arrival	0	:02	0:02	10495.37	S	54.5	94.43	0		7494.9	137.3	ю.
GOLDEN / C-470	Departure		:01	0:03	0	40	40.59		U	~	0		0
ELRANCHO / EVERGREEN	Arrival	0	:07	0:10	39797.68	65	65.99	100	Ŭ		7489.5	447.52	52
ELRANCHO / EVERGREEN	Departure		101	0:11	0	59	59.48		Ŭ	0	0		0
IDAHO SPRINGS	Arrival		0:09	0:20	64201.3	78	78.14	97.01	U	2 0	509.16	334.66	86
IDAHO SPRINGS	Departure		:01	0:21	0	72	72.33		U	~	0		0
EMPIRE	Arrival	0	:05	0:26	38000.45	80	80.19	100	U	~ (7496.91	300.22	22
EMPIRE	Departure		101	0:27	0	20	70.39		U	_	0		0
GEORGETOWN	Arrival	0	:03	0:30	21995.77	22	75.63	100	U		7497.86	171.59	59
GEORGETOWN	Departure	0	:01	0:31	0	61	61.64		U	~	0		0
LOVELAND	Arrival	0	0:08	0:39	66007.42	89	89.49	100	J	2	7504.69	705.94	94
LOVELAND	Departure	0	:01	0:40	0	82	82.14		U	~	0		0
ILVERTHORNE / DILLON	Arrival	0	201	0:47	51999.18	83	83.26	100.01	0	2 0	7495.52	123.43	43
ILVERTHORNE / DILLON	Departure		:01	0:48	0	75	75.31		U	~	0		0
FRISCO	Arrival		104	0:51	24697.07	62	79.88	100.01	Ŭ	2	7509.01	182.44	4
FRISCO	Departure	0	101	0:52	0	65	65.83		U	~	0		0
COPPER MOUNTAIN	Arrival	0	1:04	0:57	33197.38	84	84.55	100	Ŭ		7505.2	251.08	80
COPPER MOUNTAIN	Departure		0:01	0:57	0	72	72.38		U	~	0		0
VAIL	Arrival	0	0:14	1:11	113407.63	06	90.62	100	U	~ (7491.09	365.12	12
Run Total (With Dwells)		6	1:11		463799.25	73	.72	100.01	U	2 0	509.16	3019.31	31
Run Total (Without Dwells)			1:05		463799.25	81	81.41	100.01 N.A	N.A.	2	7509.16	3019.31	31

BID ITEMS	COST PER UNIT	QUANTITY	COST	· · · · ·	
Walls (SF)	90.00	1387297.00			
Earthwork (CY)	20.00	725116.00			
Pavement (TON) Base Course (CY)	70.00	0.00			
Base Course (CT) Barrier (Type 7)(LF)	60.00	0.00			
Special Structures (SF)	200.00	0.00			
Tunnel (Twin Tunnels) (LF)	15000	0.00			
Tunnel (South Bore EJMT) (LF)	30000	0.00			
Interchanges (EACH)	7000000	0.00			
Heavy Rail Structure (SF) Heavy Rail Trackwork (TF)	200	3235560.00 769696.00			
Maintenance Facilities	3	Variable			
Mobile maintenance equipment	9264000	1.00			
Signals and Controls	1000000	96.00			
Interlockings	1000000	16.00			
Stations/Parking (Large)	1000000	2.00			
Stations/Parking (Medium) Stations/Parking (Small)	6000000	4.00			
Fare Collection (fare vending machines)	38000	188.00			-
Passenger Rolling stock	2600000	285.00			1
General Construction	45240000	1.00			19.
otal			1,959,550,130.00		21
			1,808,000,100.00		1000
	120			X.	
	% Range		% Used	Cost	
			Sec. States States	A1 000 000 100 00	
Project Construction Bid Items(per segment)	Project Dependent Project Dependent		N/A N/A	\$1,209,286,130.00 \$750,264,000.00	
ump Sum Bid Items Project Construction Bid Items	Project Dependent		NA	\$1,959,550,130.00	()
reject construction bid terns	i tojeci Dependent		8 F.	\$1,333,000,100.00	4
			State Courses		
Contingencies*	(15% - 30%) of (A)		30,00% #	\$587,865,039.00	(8
				² ś	
**	10 400() - 5 (A + D)		17 Jan 1	****	
TS	(6-10%) of (A+B) Default = 6%		0,00%	\$0.00	(0
	Delaon - 070		All and a second	Si	
Drainage/Utilities	(3-10%)of (A+B)		10.00%	\$254,741,516.90	(0
	Default = 6%		10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
					<i>i</i>
Signing and Striping	(1-5%) of (A+B+C+D)		1.00%	\$28,021,566.86	(E
	Default = 5%			194 <u>9</u> 8683	
Construction Signing & Traffic Control	5 to 25% of (A+B+C+I	D+E)	7,00%	\$198,112,477.69	(F
	Default = 20%	/			
			and a second		
Mobilization	(4 to 10%) of (A+B+C	+D+E+F)	7.00%	\$211,980,351.13	(0
	Default = 7%		S.F		
Total of Construction Bid Items	(A+B+C+D+E+F+G)			\$3,240,271,081.58	(1
	(///0/0/0/2////0)			40,240,211,001.00	6
Force Account - Utilities	(1 to 2%) of (H)		2.00%	\$64,805,421.63	(
	Default = 2%			197	
	140 to 450() - (())		dia apart	0000 000 500 70	1.
Force Account - Misc.	(10 to 15%) of (H) Default = 12%	· · · · · · · · · · · · · · · · · · ·	12.00%	\$388,832,529.79	(.
	Delaul - 12%		Contraction Series		
Subtotal of Construction Cost	(H+I+J)			\$3,693,909,033.01	(1
			~ 3		
Total Construction Engineering	17% of (K)		17.00%	\$627,964,535.61	(L
			\$		
Total Broliminany Engineeringt	159(~ ///)		15.00%	CEEA DOC DEA CE	"
Total Preliminary Engineering**	15% of (K)		15.00%	\$554,086,354.95	(N
			ST. S. Barris	1	
			A PARTIE ST		
Right of Way	Project Dependent		2.00%	\$64,805,421.63	4)
141145	- Devis 1 D		NVA h		
Jtilities	Project Dependent		N/A	\$0.00	(0
	COST	QUANTITY	A States		
Tunnel (Twin Tunnels) (LF)	15000.00	0.00	Cardina and Arabitation of GOV	0.00	
Tunnel (South Bore EJMT) (LF)	30000.00	0.00		0.00	
Interchanges (EACH)	1.00	0.00	The second second	0.00	
Electrification	255000000	1.00		255,000,000.00	
				THE LOT THE OLD OF	
Total Project Cost			7 1. St. 1.	\$5,195,765,345.20	(F
Contraction of the second s					CARTER

Estimate Worksheet Hyland Hills to Jeff. Station				200-			
	% Range		% Used			1211	<u></u>
Classed Approximations							-
Stated Assumptions				A REAL		and the	
Project Construction Items		B. 11 16 A.			1		
Item Description Walls (SF)	Quantity 393376	Per Unit Cost 90		-	Cost \$35,403,840.00		
Earthwork (CY)	247681	20	境等制度	THE A	\$4,953,620.00		1
Pavement (TON)	0	70			\$0.00		
Base Course (CY) Barrier (Type 7)(LF)	32761	40			\$1,310,440.00 \$0.00		<u></u>
Special Structures (SF)	0	200			\$0.00		1
Tunnei (Twin Tunnels) (LF)	0	15000			\$0.00	家語	
Tunnel (South Bore EJMT) (LF) Interchanges (EACH)	0	30000			\$0.00		
Heavy Rall Structure	1598000	200			\$319,600,000.00		
Heavy Rall Trackwork (TF)	146000	150		ADS01	\$21,900,000.00		5
Maintenance Facilities Signals and Controls	1	35500000 1000000		and the second s	\$35,500,000.00 \$15,000,000.00	自己	
Interlockings	2	1000000		A ROL	\$2,000,000.00		100
Stations/Parking (Large)	1	1000000	AT IS	C. A. A.	\$10,000,000.00		
Stations/Parking (Medium)	0	6000000 3000000		STREET.	\$0.00		
Stations/Parking (Smail) Fare Collection	98	3000000 38000		E. C.	\$3,000,000.00		9
General Construction	1	7560000		The state	\$7,560,000.00		
Total accounted construciton items					\$459,951,900.00	(A)	Carried t
						1	
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrie	\$137,985,570.00	(B)	政 領
'S	(6-10%) of (a+b) Default = 6%		0.00%	Carrie	\$0.00	(C)	
rainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$59,793,747.00	(D)	81 121
Instant and Delater	Default = 6%		4 000				
igning and Striping	(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$6,577,312.17	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e Default = 20%)	7.00%	Сатте	\$46,501,597.04	(F)	
lobilization	(4 to 10%) of (a+b+c+d+ Default = 7%	·e+f)	7.00%	Carrie	\$49,756,708.83	(G)	<u> </u>
otal of Construction items	(a+b+c+d+e+f+g)				\$760,566,835.05	(H)	
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$15,211,336.70	(1)	
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$91,268,020.21	(J)	
ubtotal of Construction Cost	(h+i+j)				\$867,046,191.95	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$147,397,852.63	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$130,056,928.79	(M)	
ight of Way	Project Dependent		2.00%		\$15,211,336.70	(61)	
tilities	Project Dependent		N/A		@10j211j000,70	(N) (O)	
Tunnei (Twin Tunneis) (LF)	15000	0			\$0.00		8 3
Tunnel (South Bore EJMT) (LF) Interchanges (EACH) Electrification	30000 1 1	0 0 50000000			\$0.00 \$0.00 \$50,000,000.00		-
						EFT.C.L.	10
Total Segment Co		en carried to She	and the second	NAME AND	\$1,209,712,310.08	(P)	

Estimate Worksheet		and the second				12.11	<u>}</u>
US 40 to Hyland Hitts	% Range		% Used				
Stated Assumptions			Sec. 20	-			-
Project Construction Items				100 m24	······································		
Item Description	Quantity	Per Unit Cost			Cost		
Walis (SF)	0	90		230726	\$0.00		
Earthwork (CY) Pavement (TON)	0	20			\$0.00		
Base Course (CY)	93960	40	SPECT -		\$0.00		
Barrier (Type 7)(LF)	0	60		F.S.S.	\$0.00		1.00
Special Structures (SF)	0	200		HAND SE	\$0.00		
Tunnel (Twin Tunnels) (LF) Tunnel (South Bore EJMT) (LF)	0	15000			\$0.00		
Interchanges (EACH)		30000			\$0.00 \$0.00		1
Heavy Rall Structure	0	200			\$0.00		
Heavy Rall Trackwork	155136	150	States	The state	\$23,270,400.00		
Maintenance Facilities Signals and Controls	0	0			\$0.00		-
Interiockings	16	1000000 1000000			\$16,000,000.00 \$3,000,000.00		
Stations/Parking (Large)	0	1000000			\$0.00		
Stations/Parking (Medium)	0	6000000			\$0.00		1
Stations/Parking (Small)	0	3000000			\$0.00		
Fare Collection General Construction	6	38000 7730000			\$228,000.00 \$7,730,000.00		
Total accounted construction items	i	1100000	8	11-12-2015	\$53,986,800.00	(A)	Carrie
			E de la compañía	行动推			ounio
Operations	(150) 000() (1)		States in the states in			21	
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrie	\$16,196,040.00	(B)	-
Latabilaet as a percentage							
rs	(6-10%) of (a+b)		0,00%	Салте	\$0.00	(C)	10.12
	Default = 6%		S. S. S.	S. A. S.			
rainage/Water/Sewer	(2.40%) >======			1012231200	AT 010 001 00		
ranage/water/sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$7,018,284.00	(D)	
		and the second second second second	到这位				5
igning and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$772,011.24	(E)	
	Default = 5%						2
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)	7.00%	Carrie	\$5,458,119.47	(F)	
	Default = 20%	1	Links at		+0,000,000		-
A 1.00 -0				1 Ba			
foblization	(4 to 10%) of (a+b+c+d+ Default = 7%	e+f)	7.00%	Carrie	\$5,840,187.83	(G)	
	Delaute 7 %		1 1 11				******
				or to la			
otal of Construction items	(a+b+c+d+e+f+g)		18 Hall	Bo SEL	\$89,271,442.54	(H)	
			5				
orce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrier	\$1,785,428.85	(i)	
	Default = 2%		No. Const.	Carrie	\$1,100,420.00	(1)	
			12	1112月			
orce Account - Misc.	(10 to 15%) of (h)		12:00%	Carrie	\$10,712,573.10	(J)	
	Default = 12%						
ubtotal of Construction Cost	(h+i+j)		Sel la		\$101,769,444.49	(K)	-
			4月1日在1	法实现证		()	-
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$17,300,805.56	(L)	
				K Street			
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$15,265,416.67	(M)	
			SHOLL			()	
			同時時時間				
ight of Way	Project Dependent		2.00%	Sel Spinst	\$1,785,428.85	(N)	
g					ψ1,100,420.00	(14)	
liities	Project Dependent		N/A			(0)	0.00
Tunnel (Turin Tunnels) () ()	47000		で現在的に当い	的名词称		1.1	
Tunnei (Twin Tunnels) (LF) Tunnei (South Bore EJMT) (LF)	15000 30000	0			\$0.00 \$0.00		-
Interchanges (EACH)	1	0			\$0.00		
Electrification	1	51000000	A STORE		\$51,000,000.00		
			和能增	11111	0.0 X		
Total Segme	AND IT IS NOT THE TRANSPORTED BY AND ADDRESS OF THE PARTY	ALL AND DESCRIPTION OF A DESCRIPTION OF			\$187,121,095.58	(P)	191

Us 6 to US 40			De la	Statistics		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	
	% Range		% Used			Sector Sector	
Stated Assumptions						S. S. Billiott	
Stated Assumptions							
Project Construction Items				S PAGE		123-23-	
Item Description	Quantity	Per Unit Cost	ELECTION STATE		Cost	·注注的1997年	
Walls (SF) Earthwork (CY)	0	90			\$0.00	tion -	
Pavement (TON)	0	70			\$0.00		
Base Course (CY)	108494	4(\$4,339,760.00	(Tel - Leal	-
Barrier (Type 7)(LF) Special Structures (SF)	0	60		L AT	\$0.00	Roser -	
Tunnel (Twin Tunnels) (LF)		15000			\$0.00	an and	
Tunnel (South Bore EJMT) (LF)	0	30000	- CONTRACTOR OF THE OWNER	11200	\$0.00	Ale all	
Interchanges (EACH) Heavy Rail Structure	0	200			\$0.00	10000	
Heavy Rail Trackwork	174240	150			\$0.00 \$26,136,000.00	- ALL CALL	
Maintenance Facilities	0	(\$0.00		
Signals and Controls interlockings	18	1000000		E COLL	\$18,000,000.00	A A A A A	
Stations/Parking (Large)		1000000		3.3	\$1,000,000.00	and the	
Stations/Parking (Medium)	1	600000	·清.洪北明	法律师	\$6,000,000.00	海洋省合	
Stations/Parking (Small) Fare Collection	1	300000			\$3,000,000.00	201-28-61	
General Construction	14	38000			\$532,000.00	100 H 100 m 40	
		12.0000			\$7,210,000.00		
Total accounted construction items					\$66,217,760.00	(a)	arried to Sheet O
			1935-1-11-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-			1.1.1.1.1	
		,		2 10 10			
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$19,865,328.00	(B)	
Establised as a percentage							
ſS	(6-10%) of (a+b)		0:00%	Carrie	\$0.00	(C)	
	Default = 6%		SHEARAST	C-allines			
M - 15				的感情		1597.2	
Drainage/Water/Sewer	(3-10%)of (a+b) Default = 6%	· · · · ·	10.00%	Carrie	\$8,608,308.80	(D)	
	Doladit - 070					THE STREET	
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$946,913.97	(E)	
	Default = 5%			A DARMAN			
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)		7.00%	Carrie	\$6,694,681.75	(F)	
	Default = 20%		· · · · 人 尼西	語の思想			
Aobilization	(4 to 10%) of (a+b+c+d+	a+f)	7.00%	Carrie	\$7,163,309.48		
	Default = 7%	====	7.00 /8	Came	\$7,103,309.40	(G)	
						The stars	
otal of Construction Items	(a+b+c+d+e+f+g)				£400 406 202 00	0.0	
	(arbrerdrerity)				\$109,496,302.00	(H)	
			S. 27 53			S	
Force Account - Utilities	(1 to 2%) of (h) Default = 2%		2,00%	Carrie	\$2,189,926.04	(1)	
	Derault = 2%		COLUMN DESCRIPTION				
Force Account - Misc.	(10 to 15%) of (h)		12.00%	Carrie	\$13,139,556.24	(J)	
	Default = 12%		S. 1. 2000	11 12 12		Lu Astr	
Subtotal of Construction Cost	(h+i+j)				\$124,825,784.28	(K)	
				5 10 2 0 F	\$124,020,104.20		
fotal Construction Engineering	17% of (k)		17.00%	Carrie	\$21,220,383.33	(L)	
			Contraction of the	A STATE		- Bayer	
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$18,723,867.64	(M)	
			1 Alexandre				
			SP STORY SAL	12203		1	
light of Way	Project Dependent		2.00%		\$2,189,926.04	(N)	
			1.1.1	1623		Sec. B.	
Hilities	Project Dependent		N/A	The second		(0)	
Tunnel (Twin Tunnels)	15000	0		1 000076 7	\$0.00		
Tunnel (South Bore EJMT)	30000	0.5.5.5.5.6	1560° 2017	14403.0	\$0.00	ALC: NO.	
Interchanges Electrification	Name of Society of Soc	0 60000000	1976 Lach	C MALES I	\$0.00		
		0000000	C. C. Mailans	a standing	400,000,000,00		
Total Segne	and Chart Statement of the Municessing of the	THE R. P. LEWIS CO., NAME AND ADDRESS OF	CONTRACTOR OF THE OWNER.	NUL	\$226,959,961.29	(P)	

Estimate Worksheet						- o sealer	
East EJMT to US 6	% Range		% Used				
	76 Kalige		72 OSOG			PERFECTION	
Stated Assumptions				1		elluar 4. A	
Project Construction Items							
Item Description	Quantity	Per Unit Cost		C CONTRACT	Cost	1. 1995 S. 19	
Walls (SF) Earthwork (CY)	0	90		PART -	\$0.00 \$0.00		
Pavement (TON)		70		北京建一	\$0.00	ALC: NOT	<u></u>
Base Course (CY)	3359	40			\$134,360.00	California -	
Barrier (Type 7)(LF)	0	60			\$0.00		-
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0	200			\$0.00		
Tunnel (South Bore EJMT) (LF)	0	30000		(1) (1)	\$0.00		
Interchanges (EACH)	0	1	OI at		\$0.00		
Heavy Rail Structure	0	200		100	\$0.00	国内の	<u></u>
Heavy Rail Trackwork Maintenance Facilities	12144	150			\$1,821,600.00 \$0.00	-Un line	<u></u>
Signals and Controls	2	1000000		ALC: NO	\$2,000,000.00		
Interlockings	1	1000000		- Frit	\$1,000,000.00		
Stations/Parking (Large) Stations/Parking (Medium)	0	1000000		al an	\$0.00	Sin	
Stations/Parking (Medicin)	2	6000000 3000000			\$0.00 \$6,000,000.00	Star 12	
Fare Collection	3	38000			\$114,000.00	24 Exte	
General Construction	1	5020000		R BRAN	\$5,020,000.00		
Total accounted construction items				A COMPANY	\$16,089,960.00	(a)	Carried to Sheet On
			State has	STELLE	*10,000,000.00	(4)	
			A State	A MARCHA			
Contingencies	(15% - 30%) of (A)		30.00%	Carrier	\$4,826,988.00	(B)	
Establised as a percentage						E ANDER	
S	(6.10%) of (a+b)		0.00%	Rent	£0.00	10	
3	(6-10%) of (a+b) Default = 6%	1964	0.00%	Carrie	\$0.00	(C)	
			(18 ASD 18			R. S. a. A.	
rainage/Water/Sewer	(3-10%)of (a+b) Default = 6%	int in	10.00%	Carrier	\$2,091,694.80	(D)	
	Delaux = 0%			E DESERC		Setto:	
ilgning and Striptng	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$230,086.43	(E)	
	Default = 5%			CON T			
construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e	1	7.00%	Салте	\$1,626,711.05	(F)	
	Default = 20%						
1.1.W. 0	14 h 408() - (- (- (- (- (- (- (- (- (-					1000	
lobilization	(4 to 10%) of (a+b+c+d- Default = 7%	re+()	7.00%	Carrie	\$1,740,580.82	(G)	
			23-14-65	A GELLES		CAR PL	
			HEALEN	1.00	A00 000 001 00		
otal of Construction Items	(a+b+c+d+e+f+g)			CONTRACTOR AND	\$26,606,021.09	(H)	
·			ST STREET, ST	A CANCELLA		St. P. St.	
orce Account - Utilities	(1 to 2%) of (h)		2,00%	Carrie	\$532,120.42	(I)	
	Defauit = 2%		- Wardshill				
orce Account - Misc.	(10 to 15%) of (h)		12.00%	Carrle	\$3,192,722.53	(J)	
	Default = 12%		ACCESS TO T	Juno	4011321122.00	101	
	4		San Distance	1425	Ann ann	Contraction of	
ubtotal of Construction Cost	(h+l+j)			210-0	\$30,330,864.05	(K)	
otal Construction Engineering	17% of (k)	All Sugar and	17.00%	Carrie	\$5,156,246.89	(L)	
(11)							
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$4,549,629.61	(M)	
ener i remining Priditional			10.0076	Calle	94,043,023.01	(w)	
ight of Way	Project Dependent		2.00%		\$532,120.42	(N)	
			E SECTION			MAR AN	
uilties	Project Dependent		N/A	din la		(0)	
Tunnel (Twin Tunnels)	15000	0		1 1 1 1 1 1	\$0.00		
Tunnel (South Bore EJMT)	30000	0		1 1-90E 7	\$0.00		
Interchanges Electrification	That we show the processing of the	3000000	ARE STATEMENT	CONTRACTOR OF	\$0.00 \$3,000,000.00	ALC: NO.	L
	1 1		Contration of the				
Total Segment C					\$43,568,860.96	(P)	

Estimate Worksheet			County 14			的经济和	
West to East Continental Divide	% Range		% Used			s de l'An	
				100		2.21 AVA	
Stated Assumptions			NISK CO	N SALAR		and shared at	
Project Construction Items		· · · · · · · · · · · · · · · · · · ·	Standard Barries			Alw ders	
Item Description Walls (SF)	Quantity	Per Unit Cost 90			Cost	UNE SOL	5
Earthwork (CY)	0			11	\$0.00	S. P. S.	
Pavement (TON)	0	70			\$0.00	们也在自	
Base Course (CY) Barrier (Type 7)(LF)	0	40			\$0.00		<u></u>
Special Structures (SF)	Ő	200			\$0.00	CONSTRUCTS	
Tunnel (Twin Tunnels) (LF) Tunnel (South Bore EJMT) (LF)	0	15000			\$0.00	了自己的	
interchanges (EACH)	0	30000	100000000000000000000000000000000000000		\$0.00		5
Heavy Rail Structure	0	200		anut a star	\$0.00		
Heavy Rail Trackwork Maintenance Facilities	6336	150	- BRAN		\$950,400.00		1
Signals and Controls	2	1000000		-	\$0.00		
Interlockings	2	1000000		I. I.	\$2,000,000.00		5
Stations/Parking (Large)	1	1000000			\$10,000,000.00		(
Stations/Parking (Medium) Stations/Parking (Smail)	2	6000000			\$12,000,000.00 \$0.00	D Yest	0
Fare Collection	42	38000			\$1,596,000.00		
General Construction	1	20000		CP TALES	\$20,000.00		
Total accounted construction items			Second Se		\$28,566,400.00	(a)	Carried to Sheet On
			1.			Sale Sale	
			1 Martin	a Lin		Call Call State	
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$8,569,920.00	(B)	
Establised as a percentage			90 St. 1	ALC: NO.		Rat	
ſS	(6-10%) of (a+b)		0.00%	Carrie	00.03	10.5	
	Default = 6%	·····	0.00%	Came	\$0.00	(C)	
		-	A.C. GARAGE	Canada			
Drainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$3,713,632.00	(D)	
· · · · · · · · · · · · · · · · · · ·	Delduit - 0 %					Render	
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Сапте	\$408,499.52	(E)	
	Default = 5%		te provel 2				<u> </u>
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)	7.00%	Салте	\$2,888,091.61	(F)	<u> </u>
a second and a second	Default = 20%	augus		H-1 2-65			
lobilization	(4 to 10%) of (a+b+c+d+	e+f)	7,00%	Carrie	\$3,090,258.02	(G)	
	Default = 7%		Harris Break	I MARKE	43,030,230.02	10/1	
			A REAL REAL REAL REAL REAL REAL REAL REA				
otal of Construction Items	(a+b+c+d+e+f+g)		STURAL ST		\$47,236,801.15	(H)	
	(441,200,001.10	A STATES	
Come Assessed I Million	(4 h - 00() - (/h)						
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$944,736.02	(1)	
			az nast	18 14			
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$5,668,416.14	(J)	
	Default = 12%		CERTIFICATION OF				
ubtotal of Construction Cost	(h+i+j)				\$53,849,953.31	(K)	
otal Construction Engineering	179/ of ///		47.00%	in the second	to 454 100 CC	to side to	
our construction chilingannin	17% of (k)		17.00%	Carrie	\$9,154,492.06	(L)	
akal Davlasha Basha asi as				a a su			
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$8,077,493.00	(M)	
							<u> </u>
				e lest			
ight of Way	Project Dependent		2 00%		\$944,736.02	(N)	
tilities	Project Dependent		N/A			(0)	
Tunnet /Tude Tunnela	4000		Auge a Park		60.001		
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	15000	0 0			\$0.00 \$0.00		
Interchanges	1	1. Starter 205 11 51 0	Tel Rest	STREES	\$0.00	议错时	
Electrification	1	4500000		100	\$4,500,000.00	(TELEDA	
Total Segme	ent Cost		The second second		\$76,626,674.39	(8)	
	proper values have bee	Contraction of the second s	A COLORADO	States in South and	el 010401014-08	(P)	

Estimate Worksheet			記念記			清朝温的	
Vest Continental Divide to W. Vail	% Range		% Used			(1)13(2)(5) (2)15(2)(2)(2)	
Stated Assumptions			energia esta esta esta esta esta esta esta est	- Casta			
		· · · · · · · · · · · · · · · · · · ·	的國際總統	1 Hand		5,800.2	
Project Construction Items Item Description	Quantity	Per Unit Cost	et l'en rager		Cost	AND STOL	
Walts (SF)	993921	90		No. of Concession, Name	\$89,452,890.00	SIMPLY	
Earthwork (CY) Pavement (TON)	477435			S. A.S. B.	\$9,548,700.00	A Shering	
Base Course (CY)	60865				\$0.00 \$2,434,600.00	1200	
Barrier (Type 7)(LF)	0	60		William .	\$0.00	· · · · · ·	
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0				\$0.00	公 初前	
Tunnel (South Bore EJMT) (LF)					\$0.00		
Interchanges (EACH)	0		西半天的		\$0.00	A LEAD	
Heavy Rail Structure (LF) Heavy Rail Trackwork	1415800 260000				\$283,160,000.00	日本之前	
Maintenance Facilities		150 varies			\$39,000,000.00 \$39,100,000.00	Constants.	
Signals and Controls	41	1000000			\$41,000,000.00	A LEAD	
Interlockings Stations/Parking (Large)	6				\$6,000,000.00	The 1	
Stations/Parking (Large)	1	1000000			\$0.00		
Stations/Parking (Small)		3000000			\$0.00	Sec. 4	
Fare Collection General Construction	16				\$608,000.00		
General Construction		1210000			\$12,100,000.00	AGA VC	
Total accounted construction items			No STREES		\$528,404,190.00	(a)	Carried to Sheet Or
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrie	\$158,521,257.00	(B)	
						「「ないな」で	
rs	(6-10%) of (a+b) Default = 6%		0.00%	Carries	\$0.00	(C)	
rainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$68,692,544.70	(D)	
	Default = 6%						
ligning and Striping	(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$7,556,179.92	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d-	He)	7.00%	Carrie	\$53,422,192.01	(F)	
	Default = 20%		aller and and an				
fobilization	(4 to 10%) of (a+b+c+ Default = 7%	d+e+f)	7.00%	Carrie	\$57,161,745.45	(G)	
			1000-1000 (1000-1000) (1000-1000-1000-1000-1000-1000-1000-100			200	
otal of Construction Items	(a+b+c+d+e+f+g)				\$873,758,109.08	(H)	
orce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrie	\$17,475,162.18	()	
	Default = 2%						
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$104,850,973.09	(L)	
ubtotal of Construction Cost	(h+i+j)				\$996,084,244.36	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$169,334,321.54	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$140,440,000,07		
Start Fearminery Engineering	15% 01 (K)		15.00%	Came	\$149,412,636.65	(M)	
ight of Way	Project Dependent		2.00%	-	\$17,475,162.18	(N)	
tilities	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels)	15000	0			\$0.00	Contraction of the	
Tunnel (South Bore EJMT)	30000	0	SCHOOLS:	A State of	\$0.00	Sec.	
Interchanges Electrification	四40%演员上学生学习的思考的	0 81500000		1100 E	\$0.00	New Arona I	
		6100000	cruto llage	No.	\$81,500,000.00	r	
Total Segme	nt Cost		NULLES STREET	the send	\$1,413,806,364.73	(P)	

-

W. Vall to Dowds Canyon			and the second s	as Summer		ALL ALL AL	
	% Range		% Used	2.20.10		Barris and	
Stated Assumptions				101		and stores	
Project Construction Home			The Carlos of the			a sauce of	
Project Construction Items Item Description	Quantity	Per Unit Cost	Minor Maria	200211	Cost		
Walls (SF)	0	90			\$0.00	S. 120	
Earthwork (CY) Pavement (TON)	0	20			\$0.00	EAST P.	
Base Course (CY)	9976	<u>70</u> 40		LED AND	\$0.00 \$399,120.00		
Barrier (Type 7)(LF)	0	60			\$0.00		
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0	200			\$0.00		
Tunnel (South Bore EJMT) (LF)	0	15000			\$0.00	ib pr	
Interchanges (EACH)	0	1			\$0.00	Mans de C	
Heavy Rall Structure (LF)	221760	200			\$44,352,000.00	Server 1	
Heavy Rail Trackwork Maintenance Facilities	15840	1500			\$2,376,000.00 \$0.00	197 A	
Signals and Controls	2	1000000			\$2,000,000.00		
Interlockings	1	1000000			\$1,000,000.00		
Stations/Parking (Large) Stations/Parking (Medium)	0	1000000		Eu St.	\$0.00	TO BE	
Stations/Parking (Small)	0	3000000			\$0.00		
Fare Collection	9	\$38,000.00			\$342,000.00		
General Construction	1	5600000		1 12 1	\$5,600,000.00	4.285	
Total accounted construction items				-14	\$56,069,120.00	(a)	Carried to Sheet O
			THE STATE				
						STANSIST.	
Contingencles	(15% - 30%) of (A)		30.00%	Carrie	\$16,820,736.00	(B)	
Establised as a percentage			S VACUS		+ 10,020,100.00	Pingen in	
ſS	(0.408() -6 (-1))		-TROPINGED	1728			
13	(6-10%) of (a+b) Default = 6%	·	0.00%	Carrie	\$0.00	(C)	
			atter they			LINE	
Drainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$7,268,985.60	(D)	
	Delault = 6%			23 HARRINGS ST SANGERS		调封迟.	
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$801,788.42	(E)	
	Default = 5%		Section of				
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)	0	7.00%	Carrie	\$5,668,644.10	(F)	
	Default = 20%		(1)(m)(力)(k)	II FRAME	**/***/*		
Nobilization	(4 to 10%) of (atht atd)		7.00%	A REPORT	\$0.005 140 40	115	
NODM28001	(4 to 10%) of (a+b+c+d+ Default = 7%	BTI)	3.00%	Carrie	\$6,065,449.19	(G)	
				2 392-1			
otal of Construction items	(a thread to star)			1 2010	Ann 744 700 04		
our of consudcuon rems	(a+b+c+d+e+f+g)			n sancala	\$92,714,723.31	(H)	
		5-17 Dize					
orce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrie	\$1,854,294.47	(1)	
	Default = 2%		ALC: NOT A			a share	
orce Account - Misc.	(10 to 15%) of (h)		12.00%	Carrier	\$11,125,766.80	(J)	
	Default = 12%		N- INN	4		·····································	
ubtotal of Construction Cost	(h+i+j)		-21	Contraction Pro-	\$105,694,784.57	-	
			2010-01-01	81712	\$ 100,094,704.07	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$17,968,113.38	(L)	
				8-2		State and the state	
otal Preliminary Engineering	15% of (k)		15.00%	Сапіе	\$15,854,217.69	(M)	
						Contraction of the	
			COLLEGE COLLEGE]	ALC: NO	
ight of Way	Project Dependent		2.00%		\$1,854,294.47	(N)	
			后的基本的方法			President and	
tilities	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels)	15000	QUITES 12 10 10 10	Seres Sta	115 25 19	\$0.00	TANKO CAL	
Tunnel (South Bore EJMT)	30000	0	和最高级 建	13CH 7	\$0.00	and the	
Electrification		0 5000000		110281	\$0.00 \$5,000,000.00	and the second	
Liecunication		500000		141501	\$3,000,000.00	Sugar r	
Total Segme	the second se	statistics and the inclusion of the statistics	of the subsection of the	about the second second	\$146,371,410.10	(P)	

2025 Winter Saturday HR: DIA-VTC no IMC 10 cents per mile 10 minute peak headways 10 minute off-peak headways

AM is 0.25 0.4166667 Noon is 0.4166667 0.625 PM is 0.525 0.7916667 Night is 0.7916667 0.25

Mountain Rail System, Total of All Lines, Eastbound

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons Night Offs	Night Offs	Daily Ons	Daily Offs
Eagle Airport	0	0	0	0	0	0	0	0	0	0
Eagle Village	0	0	0	0	0	0	0	0	•	0
Wolcott	0	0	0	0	0	0	0	0	0	0
Avon	0	0	0	0	0	0	0	0	0	0
Vail TC	2222.3158	0	1615.6982	0	1646.7538	0	853.2903	0	6338.0581	0
Copper Mtn	274.9446	126.338	727.2326	96.2846	1116.873	125.1718	701.6926	78.8738	2820.7428	426.6682
Frisco TC	1317.0702	699.3013	2569.969	559.3175	4446.744	613.3174	2504.4432	468.5069	10838.2264	2340.4431
Silverthome TC	46.0714	381.3131	138.4328	1021.9007	171.006	918.6879	163.6072	955,3058	519.1174	3277.2075
Loveland Ski	76.6686	58.9171	355.5906	66.4138	974.634	42.3353	423.7572	43.7159	1830.6504	211.3821
Georgetown	43.3198	36.6621	119.4596	69.3481	104.6038	62.6714	136.0256	61.0099	403.4088	229.6915
Empire Jct	552.4714	92.6038	1008.201	73.9382	1549.0648	96.7937	837.7234	70.9352	3947.4606	334.2709
Idaho Spgs	110.243	35.2023	248.5508	68.0105	263.9816	76.8938	294.6446	64.0827	917.42	244.1893
US 6/Gaming	259.5706	82.6924	684.013	86.6205	1092.6574	84.8645	1532.5822	76.1665	3568.8232	330.3439
El Rancho	432.262	31.7999	682.2268	64.9632	559.1806	89.4231	601.948	79.6988	2275.6174	265.885
Jefferson	135.9794	1397.6184	262.356	2917.1727	167.1402	5747.3076	204.6432	3608.0518	770.1188	13670.1505
Arvada	0.9898	905.0451	3.5148	1511.457	2.2894	1870.5081	3.9064	1370.2175	10.7004	5657.2277
Commerce City	0.0032	309.2204	0.0016	435.2558	0.0016	385.7448	0.0004	359.086	0.0068	1489.307
Stapleton	16.288	256.502	21.1658	496.2028	14.3406	1221.1223	16.1154	550.2781	67.9098	2524.1052
DIA	0	1074.9808	0	969.5275	0	774.4276	0	488.4509	0	3307.3868
Line Totals	5488.1978	5488.1967	8436.4126	8436.4129	12109.271	12109.269	8274.3797	8274.3798	34308.2609	34308.2587

Mountain Rail System, Total of All Lines, Westbound

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons Night Offs	Night Offs	Daily Ons	Daily Offs
DIA	1103.0068	0	1195.9638	0	1275.2028	0	680.1878	0	4254.3612	
Stapleton	2020.5152	74.014	900.6866	110.2318	596.461	161.6202	572.3474	101.7798	4090.0102	447.6458
Commerce City	369.4358	61.6462	543.7453	109.0636	447.535	61.2476	417.4126	57.363	1778.1287	289.3204
Arvada	721.382	2.6746	709.0116	31.9644	566.936	2.2538	546.152	37.7218	2543.4816	74.6146
Jefferson	8331.1738	8.3128	4256.5126	132.0598	2735.9512	50.5372	2880.3452	152.706	18203.9828	343.6158
El Rancho	81.0932	358.9878	77.2604	686.8506	60.5028	603.0092	51.7246	609.971	270.581	2258.8186
US 6/Gaming	77.4034	1160.8462	88.5504	967.1268	91.3794	786.8284	69.5228	1166.6	326.856	4081.4014
Idaho Spgs	57.4984	205.2654	85.6492	324.0716	62.0484	198.7594	70.0514	215.3798	275.2474	943.4762
Empire Jct	91.3328	1993.4622	76.6968	1106.9478	98.4578	664.0254	67.9714	586.5944	334.4588	4351.0298
Georgetown	42.5466	80.0942	60.7158	128.5128	48.2616	73.074	46.6038	88.763	198.1278	370.444
Loveland Ski	22.4768	1131.1136	67.8108	363.1104	72.3374	147.6128	48.0956	226.7498	210.7206	1868.5866
Silverthome TC	954.007	105.9978	1312.0812	153.998	630.0864	73.2266	1090.0662	108.422	3986.2408	441.6444
Frisco TC	2063.2302	6612.8715	1472.7392	4156.0132	1585.7564	2710.4857	931.7526	2651.2376	6053.4784	16130.608
Copper Mtn	122.0788	1665.4751	92.0234	855.67	136.588	468.3803	88.2702	538.4466	438.9604	3527.972
Vail TC	0	2596.4154	0	1813.8336	0	2406.4438	0	1018.7743	0	7835.4671
Avon	0	0	0	0	0	0	0	0	0	0
Wolcott	0	0	0	0	0	0	0	0	0	0
Eagle Village	0	0	0	0	0	0	0	0	0	0
Eagle Airport	0	0	0	0	0	0	0	0		0
Line Totals	16057.1808	16057.1808 16057.1768 10939.4471 10939.4544 8407.5042 8407.5044 7560.5036 7560.5091 42964.6357 42964.6447	10939.4471	10939.4544	8407.5042	8407.5044	7560.5036	7560.5091	42964.6357	42964.6447

2025	Winter
HR: DIA-VTC	no IMC
	cents per mile
10	minute peak headways
10	minute off-peak headways
Feeder Bus CB1, Westbound	
Station	AM Ons
US 6 / Gaming	1263.5962
Blackhawk	47.5154
Central City	0
Line Totals	1311.1116
Feeder Bus CB1, Both Directions	
Station	AM Ons
Central City	46.72
Blackhawk	353.3799
US 6 / Gaming	1263.5962
Line Totals	1663.6961
	1003.0901
Fooder Due W/D. Foothewad	
Feeder Bus WP, Eastbound	
Station	AM Ons
Winter Park	587.3041
Empire Station	0
Line Totals	587.3041
Feeder Bus WP, Westbound	
Station	AM Ons
Empire Station	2049.2246
Winter Park	0
Line Totals	2049.2246
Feeder Bus WP, Both Directions	-
rector pue in , bear precedence	
Station	AM Ons
Winter Park	587.3041
	2049.2246
Empire Station Line Totals	
	2636.5287
Fooder Due MT. Footh averal	
Feeder Bus MT, Eastbound	
Station	AM Ons
Jefferson	894.0986
Mineral Sta	0.2229
Arapahoe pnR	0
Line Totals	894.3215
Feeder Bus MT, Westbound	
	AM Ons
Station	
Station	
Arapahoe pnR	1857.3445
Arapahoe pnR Mineral Sta	
Arapahoe pnR	1857.3445

	Fare Card Machines	lachines								
EB	Peak Fare	Feeder	Peak-	Per	7	Machine		Adjust for	Machines at	
Station	Purchase	Bus	Feeder	Hour	minute	Demand	Rounded	min	Other Locations	Total
DIA	1103	0	1103	276	552	9.2	10	10	4	1
DUSDenver Metra	No ridership					6.0	9	9	24	30
Stapleton	2037	0	2037	509	1018	17.0	17	17	2	19
Jefferson	6774	3217	3557	889	1778	29.6	30	30	5	35
El Rancho	513		513	128	257	4.3	S	S	-	9
US 6/Gaming	337		337	84	168	2.8	ŝ	e	-	4
Idaho Spgs	168		168	42	84	1.4	2	2	-	ო
Empire Jct	644	587	57	4	28	0.5	-	2	2	4
Georgetown	86		86	21	43	0.7	~	2	-	ი
Loveland Ski	66		66	25	50	0.8	-	2	-	ო
Silverthome TC	1000		1000	250	500	8.3	6	6	-	10
Frisco TC	2704		2704	676	1352	22.5	23	23	4	27
Copper Mtn	397		397	66 6	199	3.3	4	4	-	S
Vail TC	1778		1778	444	889	14.8	15	15	***	16
West of Vail									6	6
	-						Totals	130	58	188

Assumptions

Peak fare purchase was based on the sum of AM ons in both directions for winter Saturday.

Total cost \$ 7,077,636.00

time factor in minute

There will be a minimum of 2 machines at every station. Riders will purchase round trip tickets.

It takes 2 minutes for tourists to use machines.

Tickets and passes will be sold off location at convenient stores and the like.

Feeder bus users will have already purchased through tickets at resorts of other off site locations.

Assume 20% of ridership at Jefferson, Frisco, and Vail have passes

ticketing location at a retail location. Those machines have been added to the closest rail station location in the table. Resorts will Springs, Casinos, Winter Park, Keystone, Arapahoe Basin, Breckenridge, Vail Lionhead, Avon, Edwards, Eagle, Village, Eagle Other locations includes: All Denver Metra Stations, Pena, Cold Springs, Westminster, Arvada, Ward RD, Tech CTR., Mineral Airport, Gypsum, Dotsero, and Glenwood Springs. It is assumed that all areas with a rail station will have at least one off site also have fare card machines, also included here.

Summary	Entire route	63								
ITEM DESCRIPTION	UNIT	RATE UN	NITS REQ.	NITS REQ. UNIT COST TOT. UNIT COST	TOT.	UNIT COST	LABC	LABOR COST	TOTAL	FOTAL COST
12 KV Wire	Mile	e	248	18,480	φ	4,590,432.00	φ	2,754,259.20	φ	7,344,691.20
12 KV Insulators	Cat pole	ო	6,558	45	Ф	295,099.20	φ	177,059.52	φ	472,158.72
12 KV Spacers	Cat pole	ო	6,558	15	Ф	98,366.40	Ф	59,019.84	θ	157,386.24
10000 KVA Substation	Ea		12	350000	Ф	4,200,000.00	Ф	2,520,000.00	ŝ	6,720,000.00
Auto. Tie Switch	Ea.		12	5000	φ	60,000.00	θ	36,000.00	φ	96,000.00
Catenary Poles	Ea	1/200'	2,186	3000	φ	6,557,760.00	θ	3,934,656.00	ŝ	10,492,416.00
Catenary Poles XO	Еа	1	109	3000	φ	327,000.00	θ	196,200.00	ŝ	523,200.00
Catenary System Mainline	Ŧ		688,512	200	θ	137,702,400.00	⇔	82,621,440.00	÷	220,323,840.00
Cat. Sys. XO	Ft		5,500	200	φ	1,100,000.00	Ф	660,000.00	ф	1,760,000.00
Cat Sys. Passing	Ę		0	200	θ	•	Ф	'	ŝ	
SCADA	Substa.	4	12	10,000	⇔	120,000.00	⇔	72,000.00	ŝ	192,000.00
Circ. Brk. Auto Reclose	Substa.		12	40,000	Ś	480,000.00	Ф	288,000.00	€	768,000.00
					SUBT	SUBTOTAL			Ф	248,849,692
					20% (20% CONT			φ	49,769,938
									Ф	298,619,631
					Cost	Cost Rounded to	Cost	Cost Rounded to	φ	300,000,000.00

Rail

Miles	82.8
Feet	437184
Track feet	688512
Substations	12
Crossovers	1
Passing sidings	5
length of each siding (ft)	24.3
length of single track section	128304
	12.6
length of single track section	66528

Assumptions

System Voltage = 25,000 v.a.c. System Length = 82.8 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = E.) Energy required one direction = CXD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA

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Segment	Jefferson Station-Hyland Hills							
ITEM DESCRIPTION	UNIT	RATE UN	NITS REQ.	UNIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	
12 KV Wire	Mile	ო	40	18,480	734580	440748		1175328
12 KV Insulators	Cat pole	ო	1049	45	47223	28333.8		75556.8
12 KV Spacers	Cat pole	ო	1049	15	15741	9444.6		25185.6
10000 KVA Substation	Ea		2	350000	200002	7		1120000
Auto. Tie Switch	Ea.		2	5000	10000	6000		16000
Catenary Poles	Ea	1/200'	350	3000	1049400	629640		1679040
Catenary Poles XO	Ea	5	10	3000	30000	18000		48000
Catenary System Mainline	Ft		139920	200	27984000	16790400		44774400
Cat. Sys. XO	Ft		1000	200	20000	120000		320000
Cat Sys. Passing	Ft		0	200	0	0		0
SCADA	Substa.	4	2	10,000	20000	12000		32000
Circ. Brk. Auto Reclose	Substa.		2	40,000	80000	48000		128000
					SUBTOTAL		\$	49,393,510
					20% CONT		Ś	9,878,702
							\$	59,272,212
					Cost Rounded to	Cost Rounded to	\$	60,000,000

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System Voltage = 25,000 v.a.c. System Length = 86.6 miles

A.) Base Consist = 10 cars/train
B.) Base Energy required in KWH = 6,191 KWH
C.) Energy required in KVA = B.x1.38 = 8,544 KVA
C.) Number of consists required = 6
D.) Number of consists required = 6
E.) Energy required for both direction = CxD = 561,264 KVA
F.) Energy required for both directions = 2xE = 102,528 KVA
G.) Substations required(one/ stop+2) = 11
H.) Substation KVA = F/G = 8,544 KVA
I.) Double track with crossovers spaced 8 miles apart

13.25 69960 139920

2000

Passing sidings

Substations Crossovers

Miles Feet Track feet

Segment	Hyland Hills-Empire Jct							
ITEM DESCRIPTION	UNIT	RATE UNI	TS REQ. (RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	. UNIT COST	LABOR COST	TOTAL COST	OST
12 KV Wire	Mile	m	40	18,480	734580	440	440748	1175328
12 KV Insulators	Cat pole	ო	1049	45	47223	2833	28333.8	75556.8
12 KV Spacers	Cat pole	e	1049	15	15741	94	9444.6	25185.6
10000 KVA Substation	Ea		ო	350000	1050000	630	630000	1680000
Auto. Tie Switch	Ea.		e	5000	15000	6	0006	24000
Catenary Poles	Ea	1/200'	350	3000	1049400	629	629640	1679040
Catenary Poles XO	Еа	11	33	3000	00066	29	59400	158400
Catenary System Mainline	Ft		139920	200	27984000	16790400	1400	44774400
Cat. Sys. XO	Ft		1500	200	300000	180	180000	480000
Cat Sys. Passing	Ft		0	200	0		0	0
SCADA	Substa.	4	с С	10,000	30000	18	18000	48000
Circ. Brk. Auto Reclose	Substa.		ຕ	40,000	120000	72	72000	192000
	12			INS	SUBTOTAL		φ	50,311,910
				209	20% CONT		Ф	10,062,382
							Ф	60,374,292
				ő	st Rounded to	Cost Rounded to Cost Rounded to	φ	60,000,000

C.) Energy required in KVA = B.x1.38 = 8,544 KVA B.) Base Energy required in KWH = 6,191 KWH D.) Number of consists required = 6 A.) Base Consist = 10 cars/train System Voltage = 25,000 v.a.c. System Length = 86.6 miles

Assumptions

13.25 69960 139920 **ო ო Ο**

Passing sidings

Substations Crossovers

Track feet

Miles Feet

 E.) Energy required one direction = CxD = 561,264 KVA
 F.) Energy required for both directions = 2xE = 102,528 KVA I.) Double track with crossovers spaced 8 miles apart G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA

Hyl-Emp

Segment	Empire Jct-Loveland	T						
ITEM DESCRIPTION	UNIT	RATE (UNITS REQ.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	T. UNIT COST	LABOR COST	TOTA	TOTAL COST
12 KV Wire	Mile	m	50	18,480	914760	548856	G	1463616
12 KV Insulators	Cat pole	ო	1307	45	58806	35283.6	G	94089.6
12 KV Spacers	Cat pole	n	1307	15	19602	11761.2	2	31363.2
10000 KVA Substation	Ea		~	350000	350000		0	560000
Auto. Tie Switch	Ea.			5000	5000	3000	0	8000
Catenary Poles	Ea	1/200'	436	3000	1306800	784080	0	2090880
Catenary Poles XO	Ea		11	3000	33000	19800	0	52800
Catenary System Mainline	Ę		174240	200	34848000	20908800	0	55756800
Cat. Sys. XO	Ft		500	200	100000	60009	0	160000
Cat Sys. Passing	Ft		0	200	0		0	0
SCADA	Substa.	4	~	10,000	10000	6000	0	16000
Circ. Brk. Auto Reclose	Substa.		1	40,000	40000	24000	0	64000
				S	SUBTOTAL		Ś	60,297,549
				20	20% CONT		θ	12,059,510
							θ	72,357,059
				ŏ	Cost Rounded to	Cost Rounded to	ы	70.000.000

Emp-Love

16.5 87120 174240 1 1 0

Miles Feet Track feet Substations Crossovers Passing sidings

Segment	Loveland-Tu	unnel						
ITEM DESCRIPTION	UNIT	RATE UNITS	REQ.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	F. UNIT COST	LABOR COST	TOTAL COST	COST
12 KV Wire	Mile	ო	7	18,480	33264	19958.4	4	53222.4
12 KV Insulators	Cat pole	с С	48	45	2138.4	1283.04	4	3421.44
12 KV Spacers	Cat pole	ო	48	15	712.8	427.68	80	1140.48
10000 KVA Substation	Еа		~	350000	350000	210000	0	560000
Auto. Tie Switch	Ea.		Ţ	5000	5000	3000	0	8000
Catenary Poles	Ea	1/200'	16	3000	47520		2	76032
Catenary Poles XO	Еа	11	11	3000	33000	19800	0	52800
Catenary System Mainline	Ft		6336	200	1267200	760320	0	2027520
Cat. Sys. XO	Ft		500	200	100000	60000	0	160000
Cat Sys. Passing	Ħ		0	200	0		0	0
SCADA	Substa.	4	~	10,000	10000	6000	0	16000
Circ. Brk. Auto Reclose	Substa.		-	40,000	40000	24000	0	64000
				NS	SUBTOTAL		ω	3,022,136
				20	20% CONT		θ	604,427
							θ	3,626,564
				ວິ	st Rounded to	Cost Rounded to Cost Rounded to	φ	4,000,000

Assumptions System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train

B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KVA = B.x1.38 = 8.544 KVA	D.) Number of consists required = 6	E.) Energy required one direction = CxD = 561,264 KVA	F.) Energy required for both directions = $2xE = 102,528$ KVA	G.) Substations required(one/ stop+2) = 11	H.) Substation KVA = F/G = 8,544 KVA	I.) Double track with crossovers spaced 8 miles apart	
	0.6	3168	6336	-	~~	0	
	Miles	Feet	Track feet	Substations	Crossovers	Passing sidings	

Love-Tun

Segment	Eisenhower Tunnel	lei					
ITEM DESCRIPTION	UNIT	RATE UNI	IS REQ. U	NIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST
12 KV Wire	Mile	ო	2	18,480	127512	76507.2	
12 KV Insulators	Cat pole	ო	182	45	8197.2	4918.32	
12 KV Spacers	Cat pole	ო	182	15	2732.4	1639.44	
10000 KVA Substation	Ea		0	350000	0		
Auto. Tie Switch	Ea.		0	5000	0		
Catenary mounting brackets	Ea	1/200'	61	3000	182160	109296	291456
Catenary Poles XO	Ea	11	0	3000	0		
Catenary System Mainline	Ft		12144	200	2428800	1457280	3886080
Cat. Sys. XO	ŧ		0	200	0	0	
Cat Sys. Passing	Ft F		0	200	0		
SCADA	Substa.	4	0	10.000	0		
Circ. Brk. Auto Reclose	Substa.		0	40,000	0	0	
					SUBTOTAL	5	\$ 4,399,043
					20% CONT		\$ 879,809
							\$ 5,278,851
					Cost Rounded to Cost Rounded to	Cost Rounded to	\$ 5,000,000

Assumptions	System Voltage = 25,000 v.a.c.	System Length = 86.6 miles	A.) Base Consist = 10 cars/train	B.) Base Energy required in KWH = 6,191 KWH	C.) Energy required in KVA = B.x1.38 = 8,544 KVA	D.) Number of consists required = 6	E.) Energy required one direction = CxD = 561,264 KVA	F.) Energy required for both directions = $2xE = 102,528$ KVA	G.) Substations required(one/ stop+2) = 11	H.) Substation $KVA = F/G = 8,544 KVA$	I.) One track
						2.3	12144	12144	0	0	0

Ike Tunnel

Miles Feet Track feet Substations Crossovers Passing sidings

Segment	Tunnel-Vail	-9						
ITEM DESCRIPTION	UNIT	RATE UN	NITS REQ.	UNIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	ST ST
12 KV Wire	Mile	ო	111	18,480	2045736	1227441.6		3273177.6
12 KV Insulators	Cat pole	ო	2922	45	131511.6	78906.96		210418.56
12 KV Spacers	Cat pole	ო	2922	15	43837.2	26302.32		70139.52
10000 KVA Substation	Еа		5	350000	1750000			2800000
Auto. Tie Switch	Ea.		5	5000	25000	15000		40000
Catenary Poles	Еа	1/200'	974	3000	2922480	1753488		4675968
Catenary Poles XO	Еа	11	4	3000	132000	79200		211200
Catenary System Mainline	ť		215952	200	43190400	25914240		69104640
Cat. Sys. XO	ť		2000	200	40000	240000		640000
Cat Sys. Passing	ţ		0	200		0		0
SCADA	Substa.	4	5	10,000	20000	30000		80000
Circ. Brk. Auto Reclose	Substa.		5	40,000	2	~		320000
					SUBTOTAL		\$ 81	81,425,544
-					20% CONT		\$ 16	16,285,109
							\$ 97	97,710,652
					Cost Rounded to	Cost Rounded to	\$ 100	100,000,000

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Rail		Assumptions
Miles	36.9	System Voltag
Feet	194832	System Lengt
Track feet	215952	A.) Base Cons
Substations	5	B.) Base Energ
Crossovers	4	C.) Energy red
Passing sidings	7	D.) Number of
length of each siding (ft)	10,560	E.) Energy red
length of single track section	24.3 mi	F.) Energy red
	128304 ft	G.) Substation
length of single track section	12.6 mi	H.) Substation
	66528 ft	I.) Double track
		:

Tun-Vail

Total Facilities Costs

Project Construction Items				
Item Description	Quantity		Per Unit Cost	Cost
Square foot indoor space	301,098.00	\$	115.00	\$34,626,270.00
Track needed	46,953.60	\$	150.00	\$7,043,040.00
Turnouts	44.00	\$	75,000.00	\$3,300,000.00
		·	Sub total	\$44,969,310.00
Equipment				
Track Machinery Equipment				
Wheel Lathe	1	\$	1,800,000.00	\$1,800,000.00
Jacks	15	\$	750,000.00	\$11,250,000.00
Mechanical Washer	2	\$	200,000.00	\$400,000.00
			Sub total	\$13,450,000.00
			Total	\$58,419,310.00
Mobile Maintenance Equipment				
Catenary inspection and service car	1	\$	3,000,000.00	\$3,000,000.00
Maintenance locomotives	ו ס	¢ ¢	2,500,000.00	\$5,000,000.00
Snowplows	2 2	\$ \$	300,000.00	\$600,000.00
Maintenance trucks, per track mile	83	Ψ \$	8,000.00	\$664,000.00
mantenance trucks, per track time	00	Ψ	Sub total	\$9,264,000.00
			Total	
			TULA	\$67,683,310.00
Passenger Railcar Fleet	285	\$	2,600,000.00	\$741,000,000.00
			Total	\$808,683,310.00
Accumptions				

Assumptions Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail).

Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA Standards.

Heavy track maintenance will be contracted. Full capacity for snow removal and overhead wire maintenance will be provided. Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

	A	В	C	D
1				
3	Denver Facility: inspection, light maintenance and			
4	cleaning. Yard capacity for 80% of the rolling stock.	Quantity	Price	
5	Square Foot Indoor Space	91,924.00	115	\$ 10,571,260.00
6	Track needed	23476.8	150	\$3,521,520.00
7	Turnouts	22.00	75000	\$1,650,000.00
8				\$15,742,780.00
9	Project Construction Items			
10	Jacks	5	750000	\$3,750,000.00
11	Mechanical Washer	1	200000	200000
12			Total	\$ 35,435,560.00

Shop sized for four 5 car units. Additional 40% sqare footage indoor space for car washer, parts storage, storage of maintenance trucks, offices and locker facilitites and commissary.

	A	В	C	D
1				
2				
3	Frisco Facility for Inspection, Overhaul, light and heavy maintenance		a ^{ta} na maku a	
	and cleaning with yard capacity for 40% of the fleet	Quantity	Per Unit Cost	Cost
5	Indoor Square Foot	157,584.00	\$ 115.00	\$ 18,122,160.00
6	Track needed	11738.4	\$ 150.00	\$ 1,760,760.00
7	Turnouts	16.00	\$ 75,000.00	\$ 1,200,000.00
8			sub total	\$ 21,082,920.00
9	Project Construction Items			
10	Item Description	Quantity	Per Unit Cost	Cost
11	Jacks	10	\$ 750,000.00	\$ 7,500,000.00
12	Wheel lathe	1	\$ 1,800,000.00	\$ 1,800,000.00
13	Shop car mover	1	\$ 300,000.00	\$ 300,000.00
14			Total	\$ 30,682,920.00
15				,,. <u>.</u>
				*

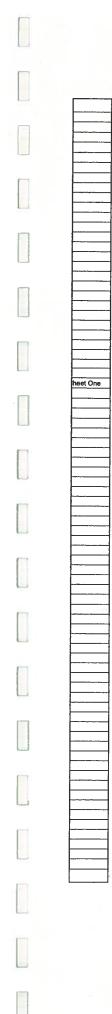
Shop sized for six 5 car units. Additional 60% sqare footage indoor space for car washer, parts warehouse, craft shop, storage of maintenance trucks, administrative offices (including dispatch office), SCADA Control Center, 16 traffic control center, training room, and locker facilitites and commissary.

	A	В	С	1002	D
1					
2					
3	Vall Facility for light car maintenance and				
4	cleaning with yard capacity for 40% of the fleet	· · · · · · · · · · · · · · · · · · ·			
5		Quantity	Price		
6	Indoor Square Foot	51,590.00	115	\$	5,932,850.00
7	Track needed	11,738.40	150	\$	1,760,760.00
8	Turnouts	6.00	75000	\$	450,000.00
9			Total	\$	8,143,610.00
10					
11	Project Construction Items				
12	Item Description	Quantity	Per Unit Cost	Cost	
13	Mechanical Washer	1	200000	\$	200,000.00
14			Total	\$	8,343,610.00
15				P	
16					
	Shop sized for one 5 car unit. Additional	100% square	footage for and	ilary fa	cilities
17	including car washer and commissary.	·	U U	,	

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COST PER UNIT	QUANTITY	COST		
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		and the second sec		
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500	455304.00			
variable	3.00	104,150,000.00		
variable	1.00	11,100,000.00		
		the second state of the se	_	
1	45240000	45,240,000.00		
		2.234,253,160.00		
		and the second	18 L	
% Range		% Used	Cost	
		the study		
		States of the second		
Design Designed				
Project Dependent		N/A	\$2,234,253,160.00	(A
(15% - 30%) of (A)		30.00%	\$670 275 048 00	(B
		30,00 %	\$670,275,948.00	(D
		金之子 明正 王莽有无		
(6-10%) of (A+B)		0.00%	\$0.00	(C
Default = 6%				(0
		and a graduated to		
(3-10%)of (A+B)		10.00%	\$290,452,910,80	(D
Default = 6%		Manager and the other		· · ·
a la construction de la construc			PA	
	D)	1,00%	\$31,949,820.19	(E)
Default = 5%		distanti di serie di di		
	+D+E)	7.00%	\$225,885,228.73	(F)
Default = 20%				
14 ha 400() - 6(A+D)	0.0.5.5	2 0 0 0		
	C+D+E+F)	7.00%	\$241,697,194.74	(G)
Detault = 1%		R. R. S. L.		
(A+B+C+D+E+E+G)		HSB2 2011上4121月1日	\$3 604 514 262 46	(H)
WILD OF DELTING		的"学生"之后,"学生"	\$3,094,314,202.40	(n)
		行行的建立物理		
(1 to 2%) of (H)		2.00%	\$73 890 285 25	(1)
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		Man and the second		
(10 to 15%) of (H)		12.00%	\$443,341,711,49	(J)
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			Vie -	
(H+I+J)			\$4,211,746,259.20	(K)
				17.65
17% of (K)		17.00%	\$715,996,864.06	(L)
			6	
450/ -6/14		AF ODA	8004	
15% of (K)		15.00%	\$631,761,938.88	(M)
1			(j)	
Project Dependent		2.00%	\$73 890 285 25	(N)
				(14)
Project Dependent		N/A	\$0.00	(0)
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		ALC: NOT ALC: NOT	\$5,942,395,347.39	
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Stated Assumptions Outside Per Unit Cost Bin Description Outside 9 150 Structures (SF) 593378 90 Base Course (CY) 0 60 Base Course (CY) 0 60 Base Course (CY) 0 60 Description 0 600 Male (CAUSE) 0 600 Description To the EATO (LY) 0 600 The act (Type 7(L)) 0 6000 Male (CAUSE (SP) 0 6000 The act (Type 7(L)) 0 6000 Male (CAUSE (SP) 0 6000 States (SP) 100000000 516,000.000 States (SP) 1 100000000 50000 States (SP) 1 1 7900000 States (SP) 1 1 7900000 States (SP) 1 3000000 50.00 States (SP) 1 3000000 50.00 50.00 States (SP) 1 3000000		% Range		% Used	·日、注:		Clark Street	
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Bruchane (F) C C State Control Barthwork (CY) 24/1681 20 55,40,540,200 Barter (Type 7(LP) 0 760 54,000 Barter (Type 7(LP) 0 60 60 Barter (Type 7(LP) 0 60 60 Speeld Structures (SP) 0 200 56,000 Turnet (Two Turnes) (LP) 0 15600 56,000 Turnet (South Beer EdM) (LP) 0 30000 5160,000 Magies Clubbarg (Srath and LP) 40000 5160,000 5160,000 Magies Clubbarg (Srath and LP) 40000 50000 5160,000,000 Stations/Funiting (Lengem) 1 1000000,000 5160,000,000 Stations/Funiting (Lengem) 132 37000,000 5160,000,000 Face Calection (Vending Mechanes) 132 37000,000 5160,000,000 510,000,000,00 Stations/Funiting (Lengem) 132 37000,000 510,550,650,00 (C) Contingencies (15%, 50%) of (a^1) 0,00% Center 510,550,650,00 (D) <td></td> <td></td> <td></td> <td>- 新聞学</td> <td>-</td> <td></td> <td>2.2</td> <td>2</td>				- 新聞学	-		2.2	2
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Fare Calceton (Vending Machines) 132 37000.00 \$4,884,000.00 General Engineering (LS) 1 758000 \$7,560,000.00 \$7,560,000.00 Total accounted construction items 1 758000 \$349,531,660.00 (A) Contingencies (15% - 30%) of (A) 30.00% Cerrine \$104,858,438.00 (B) Contingencies (6-10%) of (a+b) 0.00% Cerrine \$100,96%	Stations/Parking (Medium)							
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tail Construction Engineering 17% of (k) 17.00% Carrie \$20,288,231.56 (L) tail Preliminary Engineering 15% of (k) 15.00% Carrie \$17,901,380.79 (M) ght of Way Project Dependent 2.00% \$2,093,728,75 (N) lilities Project Dependent N/A (O) Tunnel (Twin Tunnels) (LF) 15000 0 \$0.00 Tunnel (South Bore EJMT) (LF) 30000 0 \$0.00 Interchanges (EACH) 1 60000000 \$60,000,000.00	ibtotal of Construction Cost	(h+i+i)		1. 思考回之	《神经》—	\$119 342 538 57	(10)	
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Interchanges (EACH) 1 0 \$2,093,728.75 (N) Interchanges (EACH) 1 0 \$0,000,000.00 \$0,000	otal PrellmInary Engineering	15% of (k)		15.00%	Cerrie	\$17 901 380 70	(64)	
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Tunnel (Twin Tunnels) (LF) 15000 0 \$0.00 1 Tunnel (South Bore EJMT) (LF) 30000 0 \$0.00	lition			The star	5	10,000,000,00	1 24	
Tunnel (South Bore EJMT) (LF) 30000 0 \$0.00 Interchanges (EACH) 1 0 \$0.00 Electrification 1 60000000 \$60,000,000.00	11185	Project Dependent		N/A			(0)	
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Interchanges (EACH) 1 0 \$0.00 Electrification 1 60000000 \$60,000,000.00	Tunnel (South Bore EJMT) (LF)							-
Electrification 1 60000000 \$60,000,000.00		. 1 ,	0					
	Electrification		6000000	5-4-5	· 推进 [_
Total Segment Cost \$219,625,879.66 (P)	Total Segme	Contractor	CAN SERVICE OF STREET, STRE				and the same	

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Estimate Worksheet						1468608 12	
	% Range		% Used			10120012	
Stated Assumptions			String Le	N TANK		Constant of the	
Project Construction Items						S Take Carl	Land Market
Item Description	Quantity	Per Unit Cost			Cost		
Structures (SF)	0	150			\$0.00		
Walls (SF) Earthwork (CY)	0	90			\$0.00	1. 1. 1. 1	
Pavement (TON)	0			TS REAL	\$0.00 \$0.00		
Base Course (CY)	0	4(調理の	\$0.00	Bar	
Barrier (Type 7)(LF) Special Structures (SF)	0	60		A share	\$0.00 \$0.00	S. SERVICE	
Tunnel (Twin Tunnels) (LF)	0	15000		Cull-	\$0.00	Contra St	
Tunnel (South Bore EJMT) (LF) Interchanges (EACH)	0	30000			\$0.00		
Maglev Stucture (LF)	0	4000		- 44%	\$0.00		
Maglev Guldeway	87120	500		1月1月	\$43,560,000.00		
Maintenance Facilities Signals and Controls	0	120000			\$0.00 \$21,600,000.00	pan lin	
Stations/Parking (Large)		1000000.00	Hada the		\$0.00		
Stations/Parking (Medlum) Stations/Parking (Small)	1	600000.00			\$6,000,000.00		
Fare Collection (Fare Vending Machines)	13	37000.00			\$3,000,000.00 \$481,000.00		
General Engineering (LS)	1	7210000	and the second second second	a billion	\$7,210,000.00	15月2日	
Total accounted construction items				名前部組	\$81,851,000.00	(a)	Carried to Sheet On
					\$01,031,000.00	(a)	Calmed to Sheet On
		- 1941			_		
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$24,555,300.00	(B)	
Establised as a percentage			Contraction of the	北市港		a second	
TS	(6-10%) of (a+b)		0.00%	Carrie	\$0.00	(C)	
	Default = 6%		11.0010	Callie	40.00	(0)	
Drainage/Water/Sewer	(3-10%)of (a+b)		10.009/		\$10,640,630.00		
Standger Water Office	Default = 6%		10.00%	Carrie	\$10,640,630.00	(D)	
Similar and Oldring			San gal	8		No. Alexant	
Signing and Striping	(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$1,170,469.30	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e Default = 20%)	7.00%	Carrie	\$8,275,217.95	(F)	
	Boldak - 2070					0.0	
Nobilization	(4 to 10%) of (a+b+c+d+ Default = 7%	e+f)	7.00%	Carrie	\$8,854,483.21	(G)	
	Delault = 7%		- 条件目1975 イクトの1				
Total of Construction House			HEROM	14.9			
otal of Construction Items	(a+b+c+d+e+f+g)		10-1- CA		\$135,347,100.46	(H)	
						Contraction -	
Force Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$2,706,942.01	(1)	
	Delault - 2%		Republic State	ar colast.		1.5.1.6	
Force Account - Misc.	(10 to 15%) of (h)		12.00%	Carrie	\$16,241,652.06	(J)	
	Default = 12%		A REPORT	Conversion		100	
Subtotal of Construction Cost	(h+l+j)		1		\$154,295,694.52	(K)	
Total Construction Engineering	479/ 05/14		1477 0000	1200	Ann 201 201 20		
	17% of (k)		17.00%	Carrie	\$26,230,268.07	(L)	
otal Preliminary Engineering						AND DE	
ocal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$23,144,354.18	(M)	
				8			
light of Way	Project Dependent		2.00%		\$2,706,942.01		
			13, 1000		az,100,942.01	(N)	
Vilities	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels)	15000	0			\$0.00	1. Contractor	
Tunnel (South Bore EJMT)	30000	0	95.00 S 1.00	10024	\$0.00	a Cali	
Electrification	Wester Frank Print	7000000			\$0.00 \$70,000,000.00	f la / E	
		7000000	E-CHEROLOGIC		010,000,000.00		
Total Ségmen	t Cost	Contraction (1997)	ALL ALL ALL	a subscription	\$276,377,258.78	(P)	

Kenge V.ved Kenge Bistad Assumptions Open State (Second Stat	
Bited Assumptions number of the project Construction Rems	
Project Construction Rema Quantity Per Unit Cost Cost Name Quantity Per Unit Cost Cost Cost Walk (SP) 0 20 8.00 Cost Base Corral (C) 0 20 8.00 Stop Base Corral (C) 0 3000 8.00 Stop Torned (Evon Torneak) (LP) 0 15000 8.00 Stop Major Coldward (C) 0 15000 8.00 Stop Major Coldward (Cold) 0 4000 8.00 Stop Major Coldward (C) 0 150000 8.00 Stop Major Coldward (Cold) 2 1000000 8.000 Stop Stop and and Control (C) 2 1000000 8.000 Stop Stop and and Control (Cold) 2 1000000 8.0000 Stop Stop and and Control (Cold) 1 9.00000 8.0000 Stop Stop and and Control (Control (Control (Cold) 1 9.00000 Stop Stop	
Imm Description Quantity Per Unit Cost Cost <thcost< th=""> Cost <thcost< th=""> <th< td=""><td></td></th<></thcost<></thcost<>	
Studzna (F) Dong O Bong O Store Wais (F) 0 0 20 50.00 50.00 Base Course (Y) 0 20 50.00 50.00 Base Course (Y) 0 70 50.00 50.00 Barter (Ype 7)(L) 0 60 50.00 50.00 Totand (Ym Turnels) (L) 0 15000 50.00 50.00 Majer Caldeway 3188 60.00 50.00 50.00 Majer Caldeway 3188 60.00 50.00 50.00 StateonParing (Leg) 0 1000000 60.000 50.00 StateonParing (Leg) 0 1000000 60.0000 50.00 StateonParing (Leg) 3 30000.00 510.000 60.0000 60.0000 StateonParing (Leg) 3 30000.00 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 60.0000 <t< td=""><td></td></t<>	
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Presented (TCN) 0 70 8000 Base Course (TCN) 0 40 8000 8000 Special System 21 (F) 0 1000 8000 8000 Turnel (Voit Insert EAR) 0 1000 8000 8000 Turnel (Voit Bore EART) (LP) 0 9000 8000 8000 Matching Carlier (LP) 3168 6000 8000 8000 Matching Carlier (Leg) 3168 6000 81,834,800 8000 Station Printing (Leg) 0 1000000.00 82,400,000.00 82,400,000.00 Station Printing (Leg) 0 1000000.00 82,600,000.00 8000 Station Printing (Leg) 1 522000 \$50,000,00 90000.00 Total accounted construction fear 1 522000 \$50,000,000 90000.00 Establied on a percentinge 1 522000 \$50,000,000 90000.00 Total accounted construction fear 1 5220,000 9000 (0) 1000% Establied of a percentinge <t< td=""><td></td></t<>	
Base Course (CY) 0 40 800 800 Seriel Shuthma (S) 0 60 80.00 80.00 Yama (Such Bore Shift) (LP) 0 1000 80.00 80.00 Magley Status (LP) 0 300 80.00 80.00 Magley Status (LP) 0 300 80.00 80.00 Magley Status (LP) 0 400 80.00 80.00 Status (Park) 0 400 80.00 80.00 Status (Park) 0 600000.00 82.00.00.00 82.00.00.00 Status (Park) 0 1000000.00 82.00.00.00 82.00.00.00 Status (Park) 0 1000000.00 82.00.00.00 81.00.00.00 80.00 Test account of construction terms 3 300.00.00 85.00.00.00 80.00.00 80.00.00 80.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 80.00.00.00 <td< td=""><td></td></td<>	
Barret (Type 7(LF)) 0 60 100 Special Structures (SP) 0 10000 10000 10000 Turnet (Upon Lore 2) 0 0 0000 10000 10000 Magie Oldsway 3166 6000 55.564.000.00 100000 100000	
Turnel (Vun Turnel) (LP) 0 1500 1500 Winnel (South Born EAM) (LF) 0 3000 50.00 Marker Stouker (LF) 0 0 3000 Marker Stouker (LF) 0 0 6000 Signale and Controls 2 10000000 52.000000 StationsParking (Larga) 0 100000000 52.0000000 StationsParking (Madum) 0 60000000 50.00 General Equivariant (StationsParking (Madum) 2 30000000 58.0000000 General Equivariant (StationsParking (Sta	
Tunnel (South Bore EAMT) (LF) 0 3000 1000 Marcharge (Sch1) 0 1 50.00 150.00 Marcharge (Sch1) 0 1 50.00 150.00 Signals and Controls 2 1200000 52.400.000.00 52.400.000.00 Signals and Controls 2 1200000 52.400.000.00 55.00 SistemeParing (Medium) 0 6000000.00 55.00 50.00 General Eggeweing (Small) 2 3000.00 5115.000.00 (e) Total accounted construction tems 3 37000.00 515.000 (e) (f) Contrigencies 15% - 30%) of (A) 50.00% Canter 515.00.00 (e) (f) Total accounted construction tems	
Interchanges (EAC+1) 0 10 <td></td>	
Male 3168 500 Maintenance Faillies 0 0 35,84,000.00 Statest Friding Large 1 0 1000000.00 36,000.00 First Collector (Far Verding Machine) 3 300000 55,020,000.00 1000000 Fore Collector (Far Verding Machine) 3 300000 55,020,000.00 100000 1000000 1000000 1000000 100000 100000 1000000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 1000000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 100000 1000000 1000000 1000000 <td></td>	
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Total accounted construction Items Image: Construction Items Stip:115,000.00 Open Open Contingencies (15% - 30%) of (A) 30.00% Cente \$4,534,500.00 (B) TS (6-10%) of (a+b) 0.00% Cente \$50.00 (C) DrainageWater/Sever (5-10%) of (a+b) 0.00% Cente \$50.00 (C) DrainageWater/Sever (5-10%) of (a+b) 0.00% Cente \$216,144.50 (C) DrainageWater/Sever (5-10%) of (a+b) 10.00% Cente \$216,144.50 (C) Signing and Striping (1-5%) of (a+b+crd+e) 7.00% Cente \$216,144.50 (E) Construction Signing & Traffic Control 510 25% of (a+b+crd+e) 7.00% Cente \$1,528,111.53 (G) Cold of Construction Items (a+b+crd+e+frg) 7.00% Cente \$1,635,111.53 (G) Coree Account - Ubilities (1 to 25%) of (h) 2.00% Cente \$24,903,847.64 (H) Coree Account - Misc. (1 to 15%) of (h) 12.00% Cente \$24,903,807.6	
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Establised as a percentage C </td <td></td>	
Default = 6% Dock Carite \$0.00 Carite \$0.00 (C) Drainage/Water/Sewer (3-10%, br (e+b) Default = 6% 10.00% Carite \$1,964,950.00 (D) Signing and Striping (1-5%) of (e+b+c+d) Default = 5% 10.00% Carite \$1,964,950.00 (D) Construction Signing & Traffic Control 5 to 25% of (e+b+c+d+e) 7.00% Carrie \$1,528,141.62 (F) Adobilization (4 to 10%,) of (e+b+c+d+e) 7.00% Carrie \$1,528,141.62 (F) Adobilization (4 to 10%,) of (a+b+c+d+e) 7.00% Carrie \$1,535,111.53 (G) Fotal of Construction Items (a+b+c+d+e+f+g) 7.00% Carrie \$1,635,111.53 (G) Force Account - Utilities (1 to 2%) of (h) 2.00% Carrie \$499,876.35 (I) Stubtofal of Construction Cost (10 to 15%) of (h) 12.00% Carrie \$2999,261.72 (J) Stubtofal of Construction Cost (b+i+j) \$28,482,986.31 (K) (K) Cotal Construction Cost (b+i+j) 52	
Default = 6% Construction Stable product Signing and Sirbping (1-5%) of (a+b+c+d) 1.00% Carrie \$216,144.50 (E) Default = 5% Default = 5% (F) (F) (F) (F) Default = 5% Default = 5% (F) (F) (F) (F) Default = 5% 7.00% Carrie \$1,526,141.62 (F) (F) Abbilization (d to 10%) of (a+b+c+d+e+f) 7.00% Carrie \$1,635,111.53 (G) Cotal of Construction Items (a+b+c+d+e+f+g) (a) (A) (H) (H) Coree Account - Utilities (1 to 2%) of (h) 2.00% Carrie \$499,876.95 (I) Orce Account - Utilities (1 to 15%) of (h) 12.00% Carrie \$499,876.95 (I) Orce Account - Utilities (I to 15%) of (h) 12.00% Carrie \$499,876.95 (I) Orce Account - Misc. (I to 15%) of (h) 12.00% Carrie \$4,92,986.31 (K) Otal Construction Cost (h+i+i) 10.00%	
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Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7,00% Carrie \$1,528,141.62 (F) Uobilization (4 to 10%) of (a+b+c+d+e+f) 7,00% Carrie \$1,535,111.53 (G) Mobilization (4 to 10%) of (a+b+c+d+e+f) 7,00% Carrie \$1,635,111.53 (G) Fotal of Construction Name (a+b+c+d+e+f+g) \$24,993,847.64 (H) Force Account - Ubilities (1 to 2%) of (h) 2,00% Carrie \$499,876.95 (I) Force Account - Ubilities (1 to 2%) of (h) 12,00% Carrie \$2,999,261.72 (J) Subtotal of Construction Cost (10 to 15%) of (h) 12,00% Carrie \$2,999,261.72 (J) Gotal Construction Cost (h+i+j) \$28,492,986.31 (K) (K) Total Construction Cost (h+i+j) \$28,492,986.31 (L) Cotal Construction Engineering 15% of (k) 15.00% Carrie \$4,843,807.67 (L) Idight of Way Project Dependent 2,00% \$499,876.95 (N) Hillites Projec	
Default = 20% Origination Abbilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Carrie \$1,635,111.53 (G) Default = 7% Default = 7% S24,993,847,64 (H) Fordal of Construction Items (a+b+c+d+e+f+g) S24,993,847,64 (H) Force Account - Utilities (1 to 2%) of (h) 2.00% Carrie \$499,876.95 (I) Force Account - Utilities (1 to 2%) of (h) 2.00% Carrie \$2,999,261.72 (J) Force Account - Misc. (1 to 15%) of (h) 12.00% Carrie \$28,492,986,31 (K) Subtotal of Construction Cost (h+i+i) 15.00% Carrie \$4,843,807,67 (L) Cotal Preliminary Engineering 15% of (k) 15.00% Carrie \$4,843,807,67 (L) Right of Way Project Dependent N/A (N) (N) (N) Hillites Project Dependent N/A (O) (O) (O) Tunnel (Twin Tunnels) 15000 0 \$0.00 (O) (O) Tunn	
Default = 7% Default = 12% Default = 12% </td <td></td>	
Fotal of Construction Items (a+b+c+d+e+f+g) (b) (c)	
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Default = 12% 12.00% Outro 32.935/201.12 (4) Subtotal of Construction Cost (h+i+j) \$28,492,986.31 (K) Total Construction Engineering 17% of (k) 17,00% Carrie \$4,843,807.67 (L) Total Construction Engineering 17% of (k) 17,00% Carrie \$4,843,807.67 (L) Total Preliminary Engineering 15% of (k) 15,00% Carrie \$4,273,947.95 (M) Sight of Way Project Dependent 2.00% \$499,876.95 (N) N/A (O) 15000 0 \$0.000 (O) Tunnel (Twin Tunnels) 15000 0 \$0.000 (O) Interchanges 1 0 \$0.000 (C)	
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Tunnel (Twin Tunnels) Project Dependent N/A (N) Tunnel (Twin Tunnels) 15000 0 \$0.00 Tunnel (Twin Tunnels) 30000 0 \$0.00	
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Tunnel (South Bore EJMT) 30000 0 \$0.00 Interchanges 1 0 \$0.00	
Interchanges 1 0 \$0.00	
Total Segment Cost \$42,110,818.89 (P)	

Project Dependent Project Dependent 15000 30000 1		ACEN POLY		\$0.00 \$0.00 \$0.00 \$5,000,000.00	(0)	
Project Dependent 15000 30000		N/A		\$0.00 \$0.00	S. South B.L.	
Project Dependent		N/A			S. South B.L.	
		The Design of the second		\$1,020,244.24	S. South B.L.	
		01000/	CONTRACTOR OF	\$1,026,244.24	(N)	
15% of (k)	- (** ***	15.00%	Саггіе	\$8,774,388.27	(M)	
17% of (k)	-	17.00%	Carrie	\$9,944,306.71	(L)	
(h+i+j)				\$58,495,921.82	(K)	
(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$6,157,465.45	(J)	
(1 to 2%) of (h) Default = 2%		2.00%	Carrier	\$1,026,244.24	σ	
(a+b+c+d+e+f+g)				\$51,312,212.12	(H) [_
	l+e+f)	7.00%	Carrier	\$3,356,873.69	(G)	_
5 to 25% of (a+b+c+d+ Default = 20%	e)	7.00%	Carrie	\$3,137,265.13	(F)	
(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$443,743.30	(E)	
(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$4,034,030.00	(0)	
Default = 6%						
(6-10%) of (a+b)		0.00%	Conta	\$0.00		
(15% - 30%) of (A)		30.00%	Carrier	\$9,309,300.00	(8)	
				\$31,031,000.00	(a) C	arried to Sheet One
<u> </u>				\$1,739,000.00 \$20,000.00		
0	300000.00			\$12,000,000.00 \$0.00		
	1000000.00			\$1,200,000.00 \$10,000,000.00	-	
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0	4000			\$0.00 \$0.00		
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0	200	17月1日		\$0.00	- 12	
0	40) 影子		\$0.00	NGT-	
0	20			\$0.00		
			and the second	\$0.00	all the	
Quantity	Per Unit Cost			Cost	23.19232月1日	
		Southernosti National			Finding Street	
/s rungo		10 0 000			non sinteri	
% Range		% Unad			and second	
	0 0 0 0 0 0 0 0 0 0 0 0 0 0	Quantity Per Unit Cost 0 156 0 9 0 22 0 70 0 44 0 66 0 200 0 100 0 30000 0 1500 0 100 0 4000 12144 500 0 120000 1 1200000.00 2 600000.00 3000000.00 3000000.00 1 120000 1 120000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000 1 20000	Quantity Per Unit Cost 0 150 0 90 0 200 0 70 0 40 0 200 0 70 0 100 0 1500 0 200 0 1500 0 1500 0 1500 0 15000 0 15000 0 12144 500 0 12144 500 0 120000 1 120000 1 120000 1 20000 0 30.00% 0 30.00% 0 10.00% 0 10.00% 0 10.00% 0 10.00% 0 10.00% 0 10.00% 0 10.00% 0 10.00% 0	Quantity Per Unit Cost 0 90 0 90 0 90 0 90 0 70 0 60 0 70 0 60 0 70 0 60 0 15000 0 30000 0 120000 1 1200000.00 1 1000000.00 2 600000.00 30.00% Carrie 0 30.00% 47 3700.00 1 20000 47 3700.00 1 20000 40 0.00% 1 20000 1 20000 30.00% Carrie 0 10.00% Carrie 0 10.00% Carrie 0 10.00% Carrie 0 10.00% Carrie 0	Quantity Per Unit Cost Cost 0 150 \$0.00 0 20 \$0.00 0 20 \$0.00 0 20 \$0.00 0 20 \$0.00 0 40 \$0.00 0 40 \$0.00 0 60 \$0.00 0 15000 \$0.00 0 30000 \$0.00 0 4000 \$0.00 0 4000 \$0.00 12144 500 \$1200,000.00 1200,000.00 \$1200,000.00 \$1200,000.00 10000000.00 \$1200,000.00 \$17.59,000.00 1 20000 \$17.59,000.00 1 20000 \$17.59,000.00 1 20000 \$17.59,000.00 1 20000 \$17.59,000.00 1 20000 \$17.59,000.00 1 20000 \$17.59,000.00 10.05% Carrie \$1,031,000.00	Quantity Per Unit Cost Cost 0 150 \$0.00 0 200 \$0.00 0 200 \$0.00 0 200 \$0.00 0 60 \$0.00 0 400 \$0.00 0 200 \$0.00 0 200 \$0.00 0 30000 \$0.00 0 1000000.00 \$0.00 1 12000000.00 \$12.00.00.00 2 6000000.00 \$12.00.00.00 1 1200000 \$12.00.00.00 2 6000000.00 \$13.03.00.00 1 200000 \$13.03.00.00 1 200000 \$31.03.00.00 1 200000 \$31.03.00.00 1 200000 \$31.33.00.00 1 200000 \$31.33.00.00 1 200000 \$31.33.00.00 1 200000 \$31.33.00.00 1 200000 \$31.33.30.00.00

Estimate Worksheet					Contraction of the	
	% Range		% Used		Sel Hoperate	2
Stated Assumptions					の人間にあった	
Project Construction Items					Miles Mar	
Item Description	Quantity	Per Unit Cost	The second second	Cost	の行動用は	
Structures (SF) Walls (SF)	0 481496	150		\$0.00		
Earthwork (CY)	367453	90		\$43,334,640.00 \$7,349,060.00	- Andrew	
Pavement (TON)	0	70	A DECEMBER OF A	\$0.00	和法庭行	5
Base Course (CY) Barrier (Type 7)(LF)	0	40		\$0.00	- Silver	
Special Structures (SF)	0	200	The second	\$0.00		0
Tunnel (Twin Tunnels) (LF) Tunnel (South Bore EJMT) (LF)	0	15000		\$0.00		
Interchanges (EACH)	0	1	NH TALEN	\$0.00	it the second	
Maglev Stucture (LF) Maglev Guldeway	122900	4000		\$491,600,000.00	P. E. Int	<u> </u>
Maintenance Facilities	2 va	nable		\$97,416,000.00 \$61,400,000.00		
Signals and Controls Stations/Parking (Large)	41	1200000 10000000.00		\$49,200,000.00	In the second	
Stations/Parking (Medium))	0	600000.00		\$10,000,000.00 \$0.00	105 25 65	8
Stations (Large) Fare Collection (Fare Vending Machines)	0	300000.00		\$0.00		
General Engineering (LS)	19	37000.00		\$703,000.00 \$12,100,000.00	COLUMN DE LA COLUMN	
Total accounted construction items					139764124	
Total accounted construction rems				\$773,102,700.00	(8)	Carried to Sheet On
Contingencles Establised as a percentage	(15% - 30%) of (A)		30.00% Car	tie \$231,930,810.00	(B)	
					A Branch	
15	(6-10%) of (a+b) Default = 6%		0.00% Car	rie \$0.00	(C)	
rainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00% Car	fie \$100,503,351.00	(D)	
igning and StripIng	(1-5%) of (a+b+c+d) Default = 5%		1.00% Car	ne \$11,055,368.61	(E)	
construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)		7.00% Car	rie \$78,161,456.07	(F)	
	Default = 20%					
lobilization	(4 to 10%) of (a+b+c+d+e Default = 7%	<u>++f)</u>	7.00% Car	fie \$83,632,758.00	(G)	
otat of Construction Items	(a+b+c+d+e+f+g)			\$1,278,386,443.68	(H)	
prce Account - Utilities	(1 to 2%) of (h) Default = 2%		2;00% Can	fie \$25,567,728.87	(1)	
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00% Can	te \$153,406,373.24	(L)	
ubtotal of Construction Cost	(h+i+j)			\$1,457,360,545.80	(K)	
otal Construction Engineering	17% of (k)		17.00% Can		(L)	
otal Preliminary Engineering	15% of (k)		15.00% Can	ie \$218,604,081.87	(M)	
ght of Way	Project Dependent		2.00%	\$25,567,728.87	(N)	
ilities	Project Dependent		N/A		(0)	
Tunnel (Twin Tunnels)	15000	100 - 100 Aug - 100 0		\$0.00	1 Alter	
Tunnel (South Bore EJMT) Interchanges	30000	0		\$0.00		
Electrification	THE REPORT OF A CONTRACT OF A	100000000	New York	\$100,000,000.00	19.705 AB	
	t Cost				S. P. DET	

			Du se al	RESERVEN		ALSO LESS	
· · · · · · · · · · · · · · · · · · ·	% Range		% Used				
Stated Assumptions	-						
			Sand Internet	and state		and the second	
Project Construction Items				S. C. Star			
Item Description Structures (SF)	Quantity	Per Unit Cost	A STREET STREET	Contra 191	Cost	WE BELLEVIL	
Walls (SF)				in the state	\$0.00 \$0.00	A. (1993)	-
Earthwork (CY)	- C			· · · · · · · · · · · · · · · · · · ·	\$0.00		
Pavement (TON)	C	7(「日本」を考定	\$0.00		
Base Course (CY)	C				\$0.00		
Barrier (Type 7)(LF)	C				\$0.00	STEELEN	
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0				\$0.00		
Tunnel (South Bore EJMT) (LF)					\$0.00 \$0.00	ALCONTROL	-
Interchanges (EACH)	Ő		CONTRACTOR OF THE		\$0.00		
Maglev Stucture (LF)	15840				\$63,360,000.00		-
Maglev Guideway	15840				\$7,920,000.00	Service State	
Maintenance Facilities	0				\$0.00	2	
Signals and Controls Stations/Parking (Large)	0				\$0.00		
Stations/Parking (Medium)	0				\$0.00		
Station/Parking (Small)	0				\$0.00		
Fare Collection (Fare Vending Machines)	9			ALT	\$333,000.00	A BARA	- 22
General Engineering (LS)	1	5600000			\$5,600,000.00	杨何首正汉母	
Total accounted construciton items			Supervised and			SPACE IN	
	+			ANTICALE.	\$77,213,000.00	(8) Carried	to Shee
	1		Englishen auf				+
· · · · · · · · · · · · · · · · · · ·	1		A STATE	Contraction of the second		an streets a	+
Contingencies	(15% - 30%) o	f(A)	30.00%	Carried to	\$23,163,900.00	(B)	
Establised as a percentage					1		
70	10.100			State of the second			
TS	(6-10%) of (a+I	<u>p)</u>	0.00%	Carried to	\$0.00	(C)	
	Default = 6%		Constanting of the	A CONSCIENTING		1 A	
Drainage/Water/Sewer	(3-10%)of (a+1))	10.00%	Carried to	\$10,037,690.00	(D)	
	Default = 6%		10.00 18	Samo W	\$10,000,100,001		
			計画をおい	S. JURNE			
Signing and Striping	(1-5%) of (a+b-	+c+d)	1.00%	Carried to	\$1,104,145.90	(E)	
	Default = 5%		ALL A	STORE STORES	Company and the second	STICK.	
Construction Signing & Traffic Control	5 to 25% of (a+	htctdte)	7.00%	Carried to	\$7,806,311.51	(5)	
	Default = 20%		1.0076	Carned to	\$1,000,311.51	(F)	
			ATTER			2/5-21	
Mobilization	(4 to 10%) of (a	+b+c+d+e+f)	7.00%	Carried to	\$8,352,753.32	(G)	1
· · · · · · · · · · · · · · · · · · ·	Default = 7%						
· · · · · · · · · · · · · · · · · · ·			UED PAUS			A STATE	-
Total of Construction Items	(a+b+c+d+e+f+		A CARE TO DE CARE DE CARE	Contraction of	\$127,677,800.73		
	(4.5.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	<u>عار العام الع</u>	100 - A110	CONSTRUCTION OF	\$121,011,0UU.13	(H)	
			APPENDING ST	ALCONTRACTOR			
Force Account - Utilities	(1 to 2%) of (h)		2.00%	Carried to	\$2,553,556.01	(I)	
	Default = 2%		Sugar Street .			The second	
Force Account - Misc.	(10 to 45%) -	[42.00%	STATISTICS INC.	ALE 001 000		-
ULU AUUUIIL - MISU.	(10 to 15%) of (Default = 12%	n <u>j</u>	12.00%	Carried to	\$15,321,336.09	(J)	
			ANY STORE			C. MARK	
Subtotal of Construction Cost	(h+i+j)		S stall	Section of the	\$145,552,692.83	(K)	+
			ELS LAND				1
Total Construction Engineering	17% of (k)		17.00%	Carried to	\$24,743,957.78	(L)	
	+		Press, and	to Mingle .			
Total Preliminary Engineering	15% of (k)		15.00%	Carried to	\$21,832,903.93	()4)	
section and metalling			10.0070		#£1,032,903.93	(M)	-
				INSERTION AND		1月27日1日	-
				Ser.			
Right of Way	Project Depend	ent	2.00%	14 19 10 0 Ma	\$2,553,556.01	(N)	
Jtilities	Project Depend	ont	KUA	ATT AND A			_
Juniou	in roject Depend		N/A			(0)	
Funnel (Twin Tunnels)	15000	0	NO STATES OF	1210-0127	\$0.00	at statistical sectors and	
funnel (South Bore EJMT)	30000			DUC CHE	\$0.00		
nterchanges	1月1月2日日期日	0	Star Star	E1 25 135	\$0.00		
Electrification	1	1000000	- Initial's		\$10,000,000.00	A CONTRACTOR	
							-

AGT					d,					
	Fare Card Machines	Aachines								
EB	Peak Fare	Feeder	Peak-	Per	7	Machine		Adjust for	Machines at	
Station	Purchase	Bus	Feeder	Hour	minute	Demand	Rounded	min	Other Locations	Total
DIA	1244	0	1244	311	622	10.4	11	11	4	15
DUSDenver Metra	No ridership					6.0	9	9	24	30
Stapleton	4807	0	4807	1202	2404	40.1	41	41	2	43
Jefferson	5681	1003	4678	1169	2339	39.0	39	39	5 C	4
El Rancho	670	0	670	168	335	5.6	9	9	-	7
US 6/Gaming	341	325	16	4	8	0.1	-	0	1	ო
Idaho Spgs	195	0	195	49	<u>9</u> 8	1.6	2	0	-	ო
Empire Jct	701	637	64	16	32	0.5	-	2	2	4
Georgetown	109	0	109	27	55	0.9	-	0	-	e
Loveland Ski	112	0	112	28	56	0.9	-	2	~	e
Silverthorne TC	1130	0	1130	283	565	9.4	9	10	£	1
Frisco TC	3138	0	3138	784	1569	26.1	27	27	4	31
Copper Mtn	426	0	426	107	213	3.6	4	4	-	S
Vail TC	2049	0	2049	512	1024	17.1	18	18	-	19
West of Vail									6	6
							Totals	172	58	230

Assumptions

Peak fare purchase was based on the sum of AM ons in both directions for winter Saturday.

Total cost \$ 8,658,810.00

time factor in minute

There will be a minimum of 2 machines at every station. Riders will purchase round trip tickets.

It takes 2 minutes for tourists to use machines.

Tickets and passes will be sold off location at convenient stores and the like.

Feeder bus users will have already purchased through tickets at resorts of other off site locations.

Assume 20% of ridership at Jefferson, Frisco, and Vail have passes

ticketing location at a retail location. Those machines have been added to the closest rail station location in the table. Resorts will Springs, Casinos, Winter Park, Keystone, Arapahoe Basin, Breckenridge, Vail Lionhead, Avon, Edwards, Eagle, Village, Eagle Other locations includes: All Denver Metra Stations, Pena, Cold Springs, Westminster, Arvada, Ward RD, Tech CTR., Mineral Airport, Gypsum, Dotsero, and Glenwood Springs. It is assumed that all areas with a rail station will have at least one off site also have fare card machines, also included here.

	Winter
HR: DIA-VTC	no IMC
10	cents per mile
	minute peak headways
	minute off-peak headway
Feeder Bus CB1, Westbound	
Station	AM Ons
US 6 / Gaming	1263.596
Blackhawk	47.515
Central City	47.010
Line Totals	1311.111
	1311.111
Feeder Bus CB1, Both Directions	
Station	AM One
	AM Ons
Central City	46.7
Blackhawk	353.379
US 6 / Gaming	1263.596
Line Totals	1663.696
Feeder Bus WP, Eastbound	
Station	
	AM Ons
Winter Park	587.304
Empire Station	
Line Totals	587.304
Feeder Bus WP, Westbound	
Station	AM Ons
Empire Station	2049.224
Winter Park	2045.224
Line Totais	
	2049.224
Feeder Bus WP, Both Directions	······································
Station	AM Ons
Winter Park	587.304
Empire Station Line Totals	2049.224
Line lotais	2636.528
Feeder Bus MT, Eastbound	
Station	AM Ons
Jefferson	894.098
Mineral Sta	0.222
Arapahoe pnR	(
Line Totals	894.321
Feeder Bus MT, Westbound	
Station	
	AM Ons
Arapahoe pnR	1857.344
Mineral Sta	1359.418
Jefferson	
Line Totals	3216.763

10,492,416.00 472,158.72 157,386.24 9,520,000.00 136,000.00 475,200.00 175,549,440.00 207,267,292 41,453,458 1,760,000.00 272,000.00 1,088,000.00 300,000,000.00 7,344,691.20 248,720,751 TOTAL COST ന ന θ θ θ θ \$ Э Э θ Э 59,019.84 3,570,000.00 51,000.00 3,934,656.00 178,200.00 65,831,040.00 660,000.00 102,000.00 408,000.00 2,754,259.20 177,059.52 Cost Rounded to LABOR COST က က θ Э θ 98,366.40 5,950,000.00 85,000.00 6,557,760.00 297,000.00 1,100,000.00 170,000.00 680,000.00 295,099.20 4,590,432.00 109,718,400.00 Cost Rounded to TOT. UNIT COST 20% Mag add SUBTOTAL Э Э θ θ θ 5000 3000 3000 10,000 18,480 42 15 350000 200 200 200 40,000 RATE UNITS REQ. UNIT COST 6,558 6,558 2,186 5,500 248 17 17 66 0 17 548,592 139,920 17 ∞ ოო 4 1/200' Entire route Cat pole Cat pole Substa. Substa. UNIT Mile В Ща. Ба Ба 亡 世世世 Catenary System Mainline Contact rails & supports Circ. Brk. Auto Reclose 10000 KVA Substation TEM DESCRIPTION Catenary Poles XO Cat Sys. Passing 12 KV Insulators Auto. Tie Switch Catenary Poles 12 KV Spacers Cat. Sys. XO 2 KV Wire Summary SCADA

Rail

24.3 mi 12.6 mi 66528 ft 128304 ft 82.8 437184 688512 17 ÷ 2 ength of single track section length of single track section length of each siding (ft) Passing sidings Substations Crossovers Track feet Miles Feet

System Voltage = 25,000 v.a.c. Assumptions

System Length = 82.8 miles

A.) Base Consist = 10 cars/train

B.) Base Energy required in KWH = 6,191 KWH

C.) Energy required in KVA = B.x1.38 = 8,544 KVA

D.) Number of consists required =
E.) Energy required one direction = CxD = 561,264 KVA
F.) Energy required for both directions = 2xE = 102,528 KVA

G.) Substations required(one/ stop+2) = 11

Substation KVA = F/G = 8,544 KVA Î

Segment	Jefferson Station-Hyland Hills						
ITEM DESCRIPTION	UNIT	RATE UNITS REQ.	ITS REQ. L	JNIT COST T	. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST
12 KV Wire	Mile	ო	40	18,480	734580	440748	1175328
12 KV Insulators	Cat pole	ო	1049	45	47223	28333.8	75556.8
12 KV Spacers	Cat pole	e	1049	15	15741		25185.6
10000 KVA Substation	Ea		7	350000	2450000	1470000	3920000
Auto. Tie Switch	Ea.		7	5000	35000	21000	56000
Catenary Poles	Ea	1/200'	350	3000	1049400	629640	1679040
Contact rails & supports	Ft		139920	160	22387200	13432320	35819520
Contact rails XO	Ft		1000	200	200000	120000	320000
Cat Sys. Passing	Ft		0	200	0	0	
SCADA	Substa.	4	7	10,000	20000	42000	112000
Circ. Brk. Auto Reclose	Substa.		7	40,000	280000	168000	448000
				0)	SUBTOTAL		\$ 43,630,630
				~	20% CONT		\$ 8,726,126
							\$ 52,356,756
				0	Cost Rounded to	Cost Rounded to	\$ 60,000,000

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m Voltage = 25,000 v.a.c.	m Length = 86.6 miles
System V	System L

		~
		B) Base Energy required in KMH - 6
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	A.) Base Consist = 10 cars/trair	~
2	1	~
r -	~	ш

B.) Base Energy required in KWH = 6,191 KWH
C.) Energy required in KVA = B.x1.38 = 8,544 KVA
D.) Number of consists required = 6
E.) Energy required one direction = CXD = 561,264 KVA
F.) Energy required for both directions = 2xE = 102,528 KVA
G.) Substations required(one/ stop+2) = 11
H.) Substation KVA = F/G = 8,544 KVA
I.) Double track with crossovers spaced 8 miles apart 13.25 69960 139920

N N O

Crossovers Passing sidings Substations Track feet Miles Feet

Segment	Hyland Hills-Empire Jct	×						
ITEM DESCRIPTION	UNIT	RATE U	NITS REQ.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	I. UNIT COST	LABOR COST	TOTAL COST	COST
12 KV Wire	Mile	m	40	18,480	734580		440748	1175328
12 KV Insulators	Cat pole	с С	1049	45	47223		28333.8	75556.8
12 KV Spacers	Cat pole	ო	1049	15	15741		9444.6	25185.6
10000 KVA Substation	Ea		က	350000	1050000		630000	1680000
Auto. Tie Switch	Ea.		e	5000	15000		0006	24000
Catenary Poles	Ea	1/200'	350	3000	1049400		629640	1679040
Catenary Poles XO	Ea	11	33	3000	00066		59400	158400
Catenary System Mainline	Ft		139920	200	27984000	16	16790400	44774400
Cat. Sys. XO	Ft		1500	200	300000		180000	480000
Cat Sys. Passing	Ft		0	200	0		0	0
SCADA	Substa.	4	e	10,000	30000		18000	48000
Circ. Brk. Auto Reclose	Substa.		n	40,000	120000		72000	192000
				ns	SUBTOTAL		↔	50,311,910
				20	20% CONT		Ф	10,062,382
							Ś	60,374,292
				റ്റ	Cost Rounded to	Cost Rounded to	to \$	60.000.000

System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6 E.) Energy required one direction = CXD = 561,264 KVA F.) Energy required for both directions = 2XE = 102,528 KVA G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA I.) Double track with crossovers spaced 8 miles apart

Assumptions

13.25 69960 139920 3 3 0

Miles Feet Track feet Substations Crossovers Passing sidings

Hyl-Emp

Segment	Empire Jct-Loveland	and						
ITEM DESCRIPTION	UNIT	RATE UN	ITS REQ. L	INIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	
12 KV Wire	Mile	ო	50	18,480	914760	548856		1463616
12 KV Insulators	Cat pole	ო	1307	45	58806	35283.6		94089.6
12 KV Spacers	Cat pole	က	1307	15	19602	11761.2		31363.2
10000 KVA Substation	Ea		*	350000	350000	210000		560000
Auto. Tie Switch	Ea.		~	5000	5000	3000		8000
Catenary Poles	Ea	1/200'	436	3000	1306800	784080		2090880
Catenary Poles XO	Еа	11		3000	33000	19800		52800
Catenary System Mainline	Ft		174240	200	34848000	20908800	557	55756800
Cat. Sys. XO	Ft		500	200	100000	60000		160000
Cat Sys. Passing	Ft		0	200	0			0
SCADA	Substa.	4	۲	10,000	10000	6000		16000
Circ. Brk. Auto Reclose	Substa.		-	40,000	40000	24000		64000
					SUBTOTAL		\$ 60,297,549	7,549
					20% CONT		\$ 12,05	12,059,510
							\$ 72,357,059	7,059
					Cost Rounded to	Cost Rounded to	\$ 70.000.000	00000

Assumptions System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KWA = B.x1.38 = 8,544 KVA C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6 D.) Number of consists required = 6 E.) Energy required one direction = CXD = 561,264 KVA E.) Energy required for both directions = 2XE = 102,528 KV/A G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA	1.) DOUDIE MACY WILL CLOSSOVERS SPACED O ILLIES ADAL
--	--

16.5 87120 174240 1 1 0

Miles Feet Track feet Substations Crossovers Passing sidings

Emp-Love

1140.48 8000 76032 52800 16000 64000 560000 2027520 160000 3421.44 3,626,564 3,022,136 604,427 53222 TOTAL COST Э φ φ 427.68 210000 3000 28512 60000 6000 19800 760320 24000 9958.4 1283.04 RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST 350000 10000 2138.4 712.8 5000 47520 33000 40000 000001 33264 267200 SUBTOTAL 20% CONT 10,000 18,480 5000 3000 3000 200 200 200 45 15 350000 40,000 6336 48 500 48 16 m **ო** ო F 4 1/200' Loveland-Tunnel Cat pole Cat pole Substa. Substa. Mile **S** Ба Ба. Ба В ť ť ť Catenary System Mainline Circ. Brk. Auto Reclose 10000 KVA Substation TEM DESCRIPTION Catenary Poles XO Cat Sys. Passing 12 KV Insulators Auto. Tie Switch Catenary Poles 12 KV Spacers Cat. Sys. XO 2 KV Wire Segment SCADA

4,000,000

Cost Rounded to Cost Rounded to

E.) Energy required one direction = CxD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA Double track with crossovers spaced 8 miles apart C.) Energy required in KVA = B.x1.38 = 8,544 KVA B.) Base Energy required in KWH = 6,191 KWH G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA D.) Number of consists required = 6 A.) Base Consist = 10 cars/train System Voltage = 25,000 v.a.c. System Length = 86.6 miles Assumptions 0.0 3168 6336 0

Love-Tun

Passing sidings

Substations

Track feet

Miles Feet Crossovers

Segment	Eisenhower Tunnel	nnel						
ITEM DESCRIPTION	UNIT	RATE U	VITS REQ.	UNIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	Γ
12 KV Wire	Mile	с С	7	18,480	127512	76507.2		204019.2
12 KV Insulators	Cat pole	က	182	45	8197.2	4918.32		13115.52
12 KV Spacers	Cat pole	e	182	15	2732.4	1639.44		4371.84
10000 KVA Substation	Еа		0	350000	0			0
Auto. Tie Switch	Ea.		0	5000	0	0	0	0
Catenary mounting brackets	Еа	1/200'	61	3000	182160	109296		291456
Catenary Poles XO	Eа	11	0	3000	0	0	0	0
Catenary System Mainline	Τ		12144	200	2428800	1457280		3886080
Cat. Sys. XO	F		0	200	0	U	-	0
Cat Sys. Passing	F		0	200	0	0	0	0
SCADA	Substa.	4	0	10,000	0	0	0	0
Circ. Brk. Auto Reclose	Substa.		0	40,000	0	0	0	0
					SUBTOTAL		\$ 4,399,043	,043
					20% CONT		\$ 879	879,809
							\$ 5,278,851	,851
					Cost Rounded to	Cost Rounded to	\$ 5,000,000	000

Assumptions System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KVA = B.x1.38 = 8,544 KVA C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6 E.) Energy required one direction = CxD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA I.) One track

Ike Tunnel

Passing sidings

Substations Crossovers

Track feet

Miles Feet

2.3 12144 12146 0 0

Segment	Tunnel-Vail	ui I					
ITEM DESCRIPTION	UNIT	RATE	UNITS REQ.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	T. UNIT COST L	ABOR COST	TOTAL COST
12 KV Wire	Mile	ς Γ	111	18,480	2045736	1227441.6	3273177.6
12 KV insulators	Cat pole	ς Υ	2922	45	131511.6	78906.96	210418.56
12 KV Spacers	Cat pole	ŝ	2922	15	43837.2	26302.32	
10000 KVA Substation	Ea		ъ.	350000	1750000	105000	
Auto. Tie Switch	Ea.		ŝ	5000	25000	15000	40000
Catenary Poles	Еа	1/200'	974		2922480	1753488	4675968
Catenary Poles XO	Еа	11	44	3000	132000	79200	
Catenary System Mainline	Ę		215952	200	43190400	25914240	99
Cat. Sys. XO	Ŧ		2000		400000	240000	
Cat Sys. Passing	Ŧ		0	200	0)	
SCADA	Substa.	4	ŝ	10,000	50000	30000	80000
Circ. Brk. Auto Reclose	Substa.		5	40,000	200000	120000	e
		0		าร	SUBTOTAL		\$ 81,425,544
				20	20% CONT		\$ 16,285,109
							\$ 97,710,652
				ပိ	st Rounded to (Cost Rounded to Cost Rounded to	\$ 100,000,000

s;	Track feet Substations Crossovers	Passing sidings length of each siding (ft) length of single track section	length of single track section
Rail	Track	Passir	length
Miles	Subst	length	

Assumptions System Voltage = 25,000 v.a.c.	System Lengtn = 80.0 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH	C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6	E.) Energy required one direction = CxD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA	G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA	I.) Double track with crossovers spaced 8 miles apart
36.9	194832 215952 5	4 (1	10,560 24.3 mi	128304 ft 12.6 mi	66528 ft

Tun-Vail

Maglev

Deviant Construction Home					
roject construction items Item Description	Quantity	Per Unit Cost		Cost	
Square foot indoor space	533,820.00 \$	150.00	00	\$80,073,000.00	
Track needed (TF)	40,934.40	180.00	00	\$7,368,192.00	
Turnouts	176.00 \$	90'000'06	00	\$15,840,000.00	
Transfer Table Structure	1.00	600,000.00	00	\$600,000.00	
		Sub total	al	\$103,881,192.00	
Equipment					
Jacks	15 \$	90,000,00	00	\$1,350,000.00	
Mechanical Washer	2	240,000.00	0	\$480,000.00	
		Sub total	al	\$1,830,000.00	
		Total	3	\$105,711,192.00	
Mobile Maintenance Equipment					
Inspection and service car	-	3,600,000.00	00	\$3,600,000.00	
Maintenance cars	2	3,000,000.00	0	\$6,000,000.00	
Snowplows	2	360,000.00	0	\$720,000.00	
Maintenance trucks, per track mile	83 \$	9,600.00	0	\$796,800.00	
		Sub total	al	\$11,116,800.00	
		Total	tal	\$116,827,992.00	
Passenger Railcar Fleet	52 \$	16,000,000.00	8	\$832,000,000.00	
		Total		\$948,827,992.00	

Assumptions Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail). Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA

Standards.

Heavy track maintenance will be contracted. Full capacity for snow removal and overhead wire maintenance will be provided. Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

	Α	B	0			Δ
-						
2						
3	3 Denver Facility: inspection, light maintenance and					
4	4 cleaning. Yard capacity for 80% of the rolling stock.	Quantity	Price			
S	Square Foot Indoor Space	241,080.00 \$	Ь	150.00	\$ 36,	\$ 36,162,000.00
9	Guideway	20467.2 \$	в	180.00	\$3,	\$3,684,096.00
2	Turnouts	31.00	s	90,000.00	\$2,	\$2,790,000.00
∞					\$42,	\$42,636,096.00
თ	Project Equipment Items					
10	10 Jacks	ъ С		75000	69	\$375,000.00
11	11 Mechanical Washer	1	\$ 24	240,000.00	Ь	240,000.00
12			Total		\$ 85,	85,887,192.00
	Shop sized for four 3 car units. Additional 40% soare footage indoor space for car washer, parts storage.	uare footage ind	oor space	for car was	sher, pa	irts storade.
13	13 storage of maintenance trucks, offices and locker facilitites and commissary.	r facilitites and c	ommissary			

	В		C		D
Frisco Facility for Inspection, Overhaul, light and heavy maintenance					
and cleaning with yard capacity for 40% of the fleet	Quantity	Pe	r Unit Cost	Cost	
Square Foot Indoor Space	206,640.00	\$	150.00	\$	30,996,000.00
Guideway	10233.6	\$	180.00		\$1,842,048.00
Turnouts	16.00	\$	90,000.00		\$1,440,000.00
Transfer Table Structure	1	\$	600,000.00		\$600,000.00
		sub			\$34,878,048.00
Project Equipment Items					
tem Description	Quantity	Pe	r Unit Cost	Cos	it
Jacks	10	\$	75,000.00	\$	750,000.00
Shop car mover	1	\$	300,000.00	\$	300,000.00
		Tota			
	and cleaning with yard capacity for 40% of the fleet Square Foot Indoor Space Suideway Turnouts Transfer Table Structure Project Equipment Items tem Description lacks	And cleaning with yard capacity for 40% of the fleet Quantity Square Foot Indoor Space 206,640.00 Suideway 10233.6 Turnouts 16.00 Transfer Table Structure 1 Project Equipment Items 1 tem Description Quantity Jacks 10	and cleaning with yard capacity for 40% of the fleetQuantityPeSquare Foot Indoor Space206,640.00\$Suideway10233.6\$Tumouts16.00\$Transfer Table Structure1\$Project Equipment Itemssubtem DescriptionQuantityPeJacks10\$Shop car mover1\$	Quantity Per Unit Cost Square Foot Indoor Space 206,640.00 \$ 150.00 Suideway 10233.6 \$ 180.00 'umouts 16.00 \$ 90,000.00 'ransfer Table Structure 1 \$ 600,000.00 Suideway sub \$ 90,000.00 'umouts 1 \$ 600,000.00 'ransfer Table Structure 1 \$ 600,000.00 sub Project Equipment Items \$ 90,000.00 tem Description Quantity Per Unit Cost lacks 10 \$ 75,000.00	Quantity Per Unit Cost Cost Square Foot Indoor Space 206,640.00 \$ 150.00 \$ Suideway 10233.6 \$ 180.00 \$ Tumouts 16.00 \$ 90,000.00 \$ Transfer Table Structure 1 \$ 600,000.00 \$ Project Equipment Items \$ \$ \$ tem Description Quantity Per Unit Cost Cost Shop car mover 10 \$ 75,000.00 \$

Shop sized for six 3 car units. Additional 60% sqare footage indoor space for car washer, parts warehouse, craft shop, storage of maintenance trucks, administrative offices (including dispatch office), SCADA Control Center, <u>16</u> traffic control center, training room, and locker facilitites and commissary. <u>17</u> <u>18</u>

A B C C 1 2 Nail Facility for light car maintenance and cleaning with yard capacity for 40% of the fleet C	D					\$ 12,915,000.00	\$1,842,048.00	\$11,610,000.00	\$26,367,048.00		Cost	\$ 240,000.00	\$ 26,607,048.00	
A B Vail Facility for light car maintenance and cleaning with yard capacity for 40% of the fleet B Vail Facility for light car maintenance and cleaning with yard capacity for 40% of the fleet B Square Foot Indoor Space 86, 100.00 Square Foot Indoor Space 86, 100.00 Square Foot Indoor Space 10233.6 Turnouts 129.00 Turnouts 129.00 Project Equipment Items Quantity Mechanical Washer Quantity	0				Price	150.00		\$ 90,000.00		-		240,000.00		
A Vail Facility for light car ma cleaning with yard capacity cleaning with yard capacity square Foot Indoor Space Guideway Turnouts Turnou	æ						10233.6	129.00			Quantity	~		
	A		Vail Facility for light car maintenance and	cleaning with yard capacity		Square Foot Indoor Space	Guideway	Turnouts		Project Equipment Items	Item Description	Mechanical Washer		

720/2003 13:08 BID ITEMS	COST PER UNIT	QUANTITY	COST		
Structures (SF)	150.00	0.00	0.00		
Walls (SF)	90.00	874872.00	78,738,480.00		
Earthwork (CY)	20.00	615134.00			
Pavement (TON)	70.00	0.00			
Base Course (CY)	40.00	0.00			
Barrier (Type 7)(LF)	60.00	0.00			
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	200.00	0.00		-	
Tunnel (South Bore EJMT) (LF)	30000	0.00			
Interchanges (EACH)	7000000	0.00			
Monorail Structure (LF)	4000	185740.00			
Monorail Guideway	500	455304.00			· · · ·
Maintenance Facilities	Variable	3.00			
Mobile Maintenance Equipment	Variable		10,100,000.00		
Signals and Controls	1200000	94.00			
Stations/Parking (Large)	1000000	2.00			
Stations/Parking (Medium)	6000000	4.00			
Stations/Parking (Small) Fare Collection	3000000	4.00			
General Engineering (LS)	37000	230.00			
Passenger Rolling Stock	4322500	<u> </u>			
Passenger Rolling Stock	4322300	190.00	621,275,000.00		
lotal			2,201,098,160.00		
			and the second se	100	
	W Den		er illerert	A- 4	
	% Range		% Used	Cost	
			Che Che	\$1,353,373,480.00	
			5 State	\$1,353,373,480.00	
Project Construction Bid Items	Project Dependent		N/A	\$2,174,648,480.00	(A
Contingencies*	(15% - 30%) of (A)		30.00%	\$652,394,544.00	(B
					1.1
			19-20-21-21-20		
TS	(6-10%) of (A+B)		0.00%	\$0.00	(C
	Default = 6%				
Duning and Militian	(2.409/)=6 (A + D)		10 100	1000 TO 1 000 10	(5
Drainage/Utilities	(3-10%)of (A+B) Default = 6%		10.00%	\$282,704,302.40	(D
	Delault = 0%				
Signing and Striping	(1-5%) of (A+B+C+D)		1.00%	\$31,097,473.26	(E
	Default = 5%		10070	\$01,001,470.20	(0
				4	
Construction Signing & Traffic Control	5 to 25% of (A+B+C+D	+E)	7.00%	\$219,859,135.98	(F
	Default = 20%		No. of the second	ж	
a 1.117	(4.1. 400()) (4.1.5.0)				10
Vobilization	(4 to 10%) of (A+B+C+ Default = 7%	D+E+F)	7.00%	\$235,249,275.49	(G
	Derault = 7%		4.10 1		
	-		The second second		
Fotal of Construction Bid Items	(A+B+C+D+E+F+G)		2010月1日日日	\$3,595,953,211.14	(H
				1	
Force Account - Utilities	(1 to 2%) of (H)		2.00%	\$71,919,064.22	()
	Default = 2%			71	
				4	1015
Force Account - Misc.	(10 to 15%) of (H)		12.00%	\$431,514,385.34	(J
	Default = 12%				
Subtotal of Construction Cost	(H+I+J)			\$4,099,386,660.69	(K
Value of Construction Cost	((1113)		The second	\$**,035,300,000.09	(1
Total Construction Engineering	17% of (K)		17.00%	\$696,895,732.32	(L
			Alexand Martin		(**
Total Preliminary Engineering**	15% of (K)		15.00%	\$614,907,999.10	(M
			Var Stranger		
Right of Way	Project Desertant		2.00%	\$71 010 064 00	
	Project Dependent		2.00%	\$71,919,064.22	(N
Jtilities	Project Dependent		N/A	\$0.00	(0
	. roloor populatin		4	\$0.00	10
	COST	QUANTITY		12	
Tunnel (Twin Tunnels) (LF)	15000.00	0.00		0.00	
Tunnel (South Bore EJMT) (LF)	30000.00	0.00		0.00	
Interchanges (EACH)	1.00	0.00		0.00	
Electrification	Variable	1.00	A CONTRACTOR OF A CONTRACTOR A CONTRA	251,950,000.00	
Intel Project Cost	A CONTRACTOR OF			C TOT ATA LTA A	0.94
otal Project Cost	1	THE PARTY OF ALL ST	N	\$5,735,059,456,34	(P
		A REAL PROPERTY AND A REAL			

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Total Estimate

		Contraction -	
	% Used	"是"	
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	1 ALANA	all all	
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Per Unit Cost 0 150	1. 法法律	ALL AND AL	Cost
0 150 93376 90		- Lenite-	\$0.0
47681 20			\$4,953,620.0
0 70 0 40			\$0.0 \$0.0
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0 15000			\$0.0 \$0.0
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47000 4000 69960 500		1022 ACC	\$188,000,000.0 \$34,980,000.0
1 1	Craccorescore		\$25,350,000.0
1 575000			5750
15 1200000 1 10000000.00		120	\$18,000,000.0
0 600000.00			\$0.0
1 300000.00 132 37000.00		A STATE	\$3,000,000.0 \$4,884,000.0
1 7560000		1 FREE	\$7,560,000.0
	The starts	(二) 百四日	\$0.0
			\$332,706,460.
(A)	30.00%	Carrie	\$99,811,938.0
		a i para	
1	0.00%	Carria	\$0.
)	10.00%	Carrie	\$43,251,839.
		- ACCENT	
c+d)	1.00%	Carrie	\$4,757,702.3
o+c+d+e)	7.00%	Carrie	\$33,636,955.
	E E E		
+b+c+d+e+f)	7.00%	Carria	\$35,991,542.
	1 March 1		
)			\$550,156,438.7
	2.00%	Carrie	\$11,003,128.
n)	12.00%	Carrie	\$66,018,772.
			\$627,178,340.1
	17.00%	Carrie	\$106,620,317.
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	15.00%	Carrie	\$94,076,751.
ent	2.00%		\$11,003,128.7
ent	N/A		
15000 0			\$0.0
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1 0		CONTRACTOR OF THE OWNER	\$0.0 \$43,650,000.0
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1500	00 0 1 0 1 43,650,000.00	00 0 00 0 1 0	00 0 00 0 1 0 1 43,650,000.00

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	% Range		% Used				
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Stated Assumptions					· · · · · · · · · · · · · · · · · · ·		
Project Construction Items			(4)的思	-			
item Description	Quantity	Per Unit Cost	Entra S		Cost		
Structures (SF)	0				\$0.00		
Walis (SF) Earthwork (CY)	0			金、美作-	\$0.00		
Pavement (TON)	0				\$0.00 \$0.00		
Base Course (CY)	0			the set	\$0.00		
Barrier (Type 7)(LF)	0				\$0.00		-
Special Structures (SF)	0				\$0.00		-
Tunnel (Twin Tunnels) (LF) Tunnel (South Bore EJMT) (LF)	0			17.024	\$0.00 \$0.00		
Interchanges (EACH)	0			2	\$0.00		
Monorail Structure	ő			S. S. San -	\$0.00		
Monorall Guideway	72240	500	CAR SI		\$36,120,000.00		
Maintenance Facilities					\$0.00		Terrent
Mobile Maintenance Equipment Signals and Controls	16	1200000	2 CLUSSER	100,00-	\$19,200,000.00		
Stations/Parking(Large)	0				\$0.00		-
Stations/Parking(Medium)	0	6000000.00	S. L.S.		\$0.00		
Stations/Parking(Small)	0			11	\$0.00		
Fare Collection (Vending Machines)	7				\$259,000.00		
General Engineering (LS)	1	7730000			\$7,730,000.00		
Total accounted construciton items			ALA TH		\$63,309,000.00	(A)	Carrie
				Silve Silve		• •	
				STREET.		8.5	
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrie	\$18,992,700.00	(B)	
Establised as a percentage				1111-			-
	(6-10%) of (a+b)		0.00%	Carrie	\$0.00	(C)	
	Default = 6%			-Server P		(-7	
		Cially.		的短行业		50	
inage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$8,230,170.00	(D)	1000
	Delauli = 0%			Series-			
ning and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$905,318,70	(E)	
	Default = 5%			The second		1	
struction Circles & Traffic Control	Eta DEN attachant		T abb		A. 100 000 01	<i>(</i> -)	
struction Signing & Traffic Control	5 to 25% of (a+b+c+d- Default = 20%		7.00%	Carrie	\$6,400,603.21	(F)	-
	Doidur 2070		具体建立				
vilization	(4 to 10%) of (a+b+c+	d+e+f)	7.00%	Carrie	\$6,848,645.43	(G)	-
	Default = 7%			105 6 5			
				n sann-			
al of Construction Items	(a+b+c+d+e+f+g)		ALL Y	Nr. A	\$104,686,437.34	(H)	
			- Control	S. S. Clay	• • • • • • • • • • • • • • • •	()	
			な法理ない	Rental			
ce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrie	\$2,093,728.75	(i)	_
	Default = 2%		ALL ALL				
e Account - Misc.	(10 to 15%) of (h)		12.00%	Салтіе	\$12,562,372.48	(J)	
	Default = 12%		THE L			(3)	
			10.00				
total of Construction Cost	(h+i+j)		E Contraction	CARLES .	\$119,342,538.57	(K)	
al Construction Engineering	17% of (k)		17.00%	Carrie	\$20,288,231.56	(L)	
				0 states	WEU,E00,E01.00	(-)	
			Contraction of the	15 AS			
I Preliminary Engineering	15% of (k)		15.00%	Carrie	\$17,901,380.79	(M)	
			a second				
nt of Way	Project Dependent		2.00%		\$2,093,728.75	(N)	
te z	Desile et C		CENTRAL C				
lles	Project Dependent		N/A	and the		(0)	
Tunnei (Twin Tunneis) (LF)	15000	0	CONVERSION	and the state	\$0.00		-
Tunnel (South Bore EJMT) (LF)	30000				\$0.00		1.55
Interchanges (EACH)	2 1	0		-	\$0.00		
		5050000		Designed to the	\$50,500,000.00		
Electrification	1	50500000	S. 1918	25 State	\$30,300,000.00		

Establised as a percentage Image: Construction Signing & Traffic Control 0.00% Construction Signing & Traffic Control 0.00% Construction Signing & Traffic Control 10.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 7.00% Construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Construction Signing & Traffic Control 7.00% Construction Signing & Tr		0969194
State Assumptions Project Construction fisms Quality Per Unit Cost Iem Boscpion Quality Per Unit Cost 90 Evisits (1) 0 160 Base Course (SY) 0 60 Tonnel (South Bore ELMT) (LP) 0 100000 Mooral Couldness 87120 600 Mobite Metinance Equipment 1 1000000.00 Stations Parking (Lago) 0 1000000.00 Stations Parking (Lago) 1 17210000 Total accounted construction Items 1 17210000 Total accounted construction Items 1 10.00% 0 Contingencies (15% - 30%) of (A) 30.00% 0		(A) 新学校(A) 教育教育教授
Project Construction flams Quality Per Unit Cost Bruchers (SF) 0 150 Walls (SF) 0 90 Base Course (CY) 0 70 Base Course (CY) 0 70 Base Course (CY) 0 70 Tunnel (South Bore E.MT) 0 15000 Tunnel (South Bore E.MT) 0 15000 Moncrail Structures 87120 600 Moncrail Structures 87120 600 StationsParking (Large) 1 100000000 StationsParking (Large) 1 7200000 StationsParking (Large) 1 7200000 StationsParking (Large) 1 7200000 StationsParking (Large) 1 720000 StationsParking (Modurn) 1 7200000 Fare Collection (Fare Vording Matches) 13 37000.00 General Engineering (LS) 1 720000 Total accounted construction itams 1 720000 Contingencies (15%) of (a+b) 0.00%		
Item Description Quantity Per Unit Cost Walts (SP) 0 90 Bartmork (CY) 0 70 Base Course (CF) 0 40 Special Structures (SP) 0 70 Date Course (CF) 0 40 Special Structures (SP) 0 700 Tunnel (South Bore E.MT) (LF) 0 30000 Interchanges (ACH) 0 1 Monaral Structures 0 4000 StationeParking (Large) 1 6 StationeParking (Large) 1 72000000 Total accounted construction items 1 72000000 Contingencies (15% - 30%) of (A) 0.00% c Contingencies (15% - 30%) of (A) 0.00% c Contingencies (15% - 30%) of (A)		当 家会经过
Structures (SF) 0 150 Base Course (CN) 0 20 Paxment (CN) 0 70 Base Course (CN) 0 40 Special Signal	Cost	日本にはな
Earthwork (CV) 0 20 Pervenue (TON) 0 70 Base Course (CV) 0 40 Barrier (Type 7)(LF) 0 600 Tunnel (South Structures (SF) 0 30000 Tunnel (South Structures (SF) 0 30000 Interchange (ACR) 0 4000 Monaral (Guidway 0 4000 Monaral (Guidway 0 4000 Monaral Guidway 0 4000 Monaral Guidway 0 4000 Signela and Controls 18 100000000 StationsParking (Medium) 1 6000000.00 StationsParking (Medium) 1 7000.00 General Engineeting (LS) 1 7210000 Total accounted construction Items 0 0.00% Cc Estabilised as a percentage (15% - 30%) of (A) 0.00% Cc Grant = 6% 0 0.00% Cc Contingencies 10.00% Cc Grant = 6% 0 0.00% Cc <	\$0.00	1999-397-18
Pavement (ToN) 0 70 Base Course (Yr) 0 40 Barrier (Type 7)(LF) 0 100 Tunnel (Suth Bore EMT) (LF) 0 15000 Tunnel (Suth Bore EMT) (LF) 0 15000 Monoral Structure 0 4000 Monoral Structure 0 10000 Monoral Structure 0 1000000 Monoral Structure 0 100000000 StationsParing (Medum) 1 60000000 StationsParing (Medum) 1 7210000 Contingencies (15% - 30%) of (A) 30.00% Contingencies (15% - 30%) of (A) 30.00% c Contingencies (15% of (A)	\$0.00	
Barrier (Type 7)(LP) 0 60 Special Structures (SF) 0 200 Tunnel (South Bore EMT) (LP) 0 15000 Monorall Structure 0 4000 Monorall Structure 0 10000000 StationsParking (Medium) 0 100000000 StationsParking (Smail) 1 3000000 General Engineering (LS) 1 7210000 Total accounted construction Items 1 7210000 Contingencies (15% - 30%) of (A) 30.80% c Contingencies (15% - 30%) of (a+b) 0.00% c Contingencies (15% - 30%) of (a+b) 0.00% c graing and Striping (15% - 30%) of (a+bc+cd+e) 7.00% c onstruction Signing & Traffic Control 5 to 25% of (a+bc+cd+e) 7.00% c oblization	\$0.00	
Special Structures (SF) 0 200 Tunnel (South Bore E.MT) (LF) 0 15000 Interchange (EACH) 0 4000 Monorall Structure 0 4000 Monorall Guideway 87120 500 Maintenance Facilities	\$0.00	
Turnet (South Sore EMT) (LF) 0 30000 Interchange (EACH) 0 4000 Monoral Structure 0 4000 Monoral Structure 0 4000 Monoral Structure 0 4000 Maintenance Facilities 87120 500 Mobile Maintenance Explorent 1 1200000.00 Stations/Parking (Margo) 1 6000000.00 Stations/Parking (Margo) 1 300000.00 General Engineering (LS) 1 771000 Total accounted construction items 7014 30.00% Cr Contingencies (15% - 30%) of (A) 30.00% Cr Establised as a percentage 1 30.00% Cr S (6-10%) of (a+b) 0.00% Cr Default = 6% 0.00% Cr 0 gring and Striping (1-5%) of (a+b+c+d+e) 10.00% Cr Default = 5% 0 0.00% Cr postuction Signing & Traffic Control 5 to 52% of (a+b+c+d+e) 7.00% Cr <td>\$0.00</td> <td></td>	\$0.00	
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Monoral Guideway 87120 500 Mobile Maintenance Equipment 18 120000 Signals and Controls 18 1800000.00 StationsParking (Medium) 1 8000000.00 StationsParking (Medium) 1 300000.00 StationsParking (Medium) 1 300000.00 General Engineering (LS) 1 7210000 Total accounted construction items 1 30.00% Cr Contingencies (15% - 30%) of (A) 30.00% Cr Establised as a percentage 0 10.00% Cr S (6+10%) of (a+b) 0.00% Cr rainage/Water/Sewer (3-10%) of (a+b) 10.00% Cr orstruction Signing & Traffic Control 5 to 25% of (a+b+c+c+g) 10.00% Cr oblitzation (4 to 10%) of (a+b-c+d+g) 7.00% Cr otal of Construction Items 0 0 7.00% Cr orad Account - Utilities (1 to 2%) of (n) 2.00% Cr orad Account - Utilities (1 to 2%) of (n)	\$0.00	
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Stations/Parking (Small) 1 300000.00 Fere Collection (Free Vending Machines) 1 7210000 Total accounted construction items 1 7210000 Total accounted construction items 1 7210000 Contingencies (15% - 30%) of (A) 30.00% Establised as a percentage 0 0.00% Cr S (6-10%) of (a+b) 0.00% Cr rainage/Water/Sewer (3-10%, b/ (a+b) 0.00% Cr igning and Striping (1-5%) of (a+b+c+d) 10.00% Cr igning and Striping (1-5%) of (a+b+c+d+e) 10.00% Cr onstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Cr oblization (4 to 10%) of (a+b+c+d+e+f+g) 7.00% Cr oblization (4 to 10%) of (a+b+c+d+e+f+g) 2.00% Cr otal of Construction items (a+b+c+d+e+f+g) 2.00% Cr otal of Construction items (a+b+c+d+e+f+g) 2.00% Cr otal of Construction Cost (1 to 15%) of (h) 12.00%	\$0.00	
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Total accounted construction items	\$481,000.00	
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Establised as a percentage Image: Market // Sewer Image: Market // Se	Sector Se	> 20% 有公告
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S (6-10%) of (a+b) D.00% Ca Default = 6% 0.00% Ca gring and Striping (1-5%) of (a+b+c+d) 10.00% Ca gring and Striping (1-5%) of (a+b+c+d) 10.00% Ca onstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Ca oblitzation (4 to 10%) of (a+b+c+d+e) 7.00% Ca oblitzation (4 to 10%) of (a+b+c+d+e) 7.00% Ca oblitzation (1 to 2%) of (n) 2.00% Ca otal of Construction Items (1 to 2%) of (n) 2.00% Ca orce Account - Utilities (1 to 2%) of (n) 2.00% Ca orce Account - Misc. (10 to 15%) of (n) 12.00% Ca otal of Construction Cost (n+i+j) 12.00% Ca stat Preliminary Engineering 15% of (k) 17.00% Ca otal Preliminary Engineering 15% of (k) 15.00% Ca stat Preliminary Engineering 15% of (k) 15.00% Ca otal Ordinary Engineering	Carrie \$24,555,300.00	(B)
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rainage/Water/Sewer (3-10%)of (a+b) 10.00% Cr Ugning and Striping (1-5%) of (a+b+c+d) 10.00% Cr igning and Striping (1-5%) of (a+b+c+d) 10.00% Cr onstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Cr oblitization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cr oblitization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cr oblat of Construction Items (a+b+c+d+e+f+g) 7.00% Cr orce Account - Utilities (1 to 2%) of (h) 2.00% Cr orce Account - Utilities (10 to 15%) of (h) 12.00% Cr otal of Construction Items (10 to 15%) of (h) 12.00% Cr orce Account - Utilities (10 to 15%) of (h) 12.00% Cr obtal of Construction Cost (h+i+i) 15.00% Cr otal Preliminary Engineering 15% of (k) 15.00% Cr otal Construction Engineering 15% of (k) 15.00% Cr otal Preliminary Engineering 15% of (k) 15.00% Cr otal Of Way Project Dependent <td>Carrie \$0.00</td> <td>(C)</td>	Carrie \$0.00	(C)
Default = 6% 1.00% Cc igning and Striping (1-5%) of (a+b+c+d) 1.00% Cc onstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Cc oblization (4 to 10%) of (a+b+c+d+e) 7.00% Cc oblization (1 to 2%) of (h) 2.00% Cc orce Account - Utilities (1 to 2%) of (h) 12.00% Cc orce Account - Utilities (1 to 2%) of (h) 12.00% Cc orce Account - Utilities (1 to 2%) of (h) 12.00% Cc orce Account - Misc. (1 to 15%) of (h) 12.00% Cc otal Construction Engineering 17% of (k) 17.00% Cc otal Preliminary Engineering 15% of (k) 15.00% Cc otal Preliminary Engineering 15% of (k) 15.00% Cc otal Preliminary	Real Provide State	
igning and Striping (1-5%) of (a+b+c+d) 1.00% Ca ionstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Ca iobilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Ca iobilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Ca iobilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Ca iobal of Construction Items (a+b+c+d+e+f+g) 7.00% Ca orce Account - Utilities (1 to 2%) of (h) 2.00% Ca orce Account - Misc. (1 to 10%) of (h) 12.00% Ca ubtotal of Construction Cost (h+i+i) 12.00% Ca otal Preliminary Engineering 17% of (k) 17.00% Ca ight of Way Project Dependent 2.00% Ca itities Project Dependent 2.00% Ca itities Project Dependent 2.00% Ca itities Project Dependent 0 0	Carrie \$10,640,630.00	(D)
Default = 5% 7.00% Cc construction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Cc lobilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cc otal of Construction Items (a+b+c+d+e+f+g) 7.00% Cc otal of Construction Items (a+b+c+d+e+f+g) 7.00% Cc orce Account - Utilities (1 to 2%) of (h) 2.00% Cc orce Account - Misc. (1 to 2%) of (h) 12.00% Cc orce Account - Misc. (1 to 15%) of (h) 12.00% Cc otal of Construction Cest (h+i+i) 0 0 0 otal of Construction Cest (h+i+i) 0 0 0 0 otal Preliminary Engineering 17% of (k) 15.00% Ca 0 0 0 0 tilities Project Dependent 2.00% 15.00% 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 <	(1996) (1996)	6/2/6/8
onstruction Signing & Traffic Control 5 to 25% of (a+b+c+d+e) 7.00% Cc obilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cc obilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cc obilization (4 to 10%) of (a+b+c+d+e+f) 7.00% Cc obtail of Construction Items (a+b+c+d+e+f+g) 1 1 orce Account - Utilities (1 to 2%) of (h) 2.00% Cc orce Account - Misc. (1 to 15%) of (h) 12.00% Cc orce Account - Misc. (1 to 15%) of (h) 12.00% Cc otal Construction Cost (h+i+j) 12.00% Cc otal Construction Engineering 17% of (k) 17.00% Cc otal Preliminary Engineering 15% of (k) 15.00% Cc otal Preliminary Engineering 15% of (k) 15.00% <td< td=""><td>Carrie: \$1,170,469.30</td><td>(E)</td></td<>	Carrie: \$1,170,469.30	(E)
Default = 20% Intercharges Iobilization (4 to 10%) of (a+b+c+d+e+f) 7,00% Default = 7% Intercharges Iobilization (4 to 10%) of (a+b+c+d+e+f) 7,00% Default = 7% Intercharges Iobilization (a+b+c+d+e+f) 7,00% Iobilization (a+b+c+d+e+f+g) Iobilization (a+b+c+d+e+f+g) Iobilization (1 to 2%) of (h) 2.00% Iobilization (1 to 2%) of (h) 2.00% Iobilization (1 to 2%) of (h) 2.00% Iobilization (1 to 15%) of (h) 12.00% Iobilization (1 to 15%) of (h) 12.00% Ca Iobilization Intercharges Intercharges Intercharges		
iobilization (4 to 10%) of (a+b+c+d+e+f) 7,00% Cr Default = 7%	Carrie \$8,275,217.95	(F)
Default = 7% 0 otal of Construction Items (a+b+c+d+e+f+g) orce Account - Utilities (1 to 2%) of (h) 2.00% orce Account - Misc. (1 to 15%) of (h) 2.00% Cr orce Account - Misc. (10 to 15%) of (h) 12.00% Cr orce Account - Misc. (10 to 15%) of (h) 12.00% Cr obtail Construction Cost (h+i+i) 12.00% Cr obtail Construction Engineering 17% of (k) 17.00% Cr obtail Preliminary Engineering 15% of (k) 15.00% Cr obtail of Way Project Dependent 2.00% Cr ilities Project Dependent N/A 0 Tunnel (Twin Tunnels) 15000 0 0	Ris III	and and a second second
otal of Construction Items (a+b+c+d+a+f+g) orce Account - Utilities (1 to 2%) of (h) orce Account - Misc. (1 to 2%) of (h) orce Account - Misc. (10 to 15%) of (h) orce Account - Misc. (10 to 15%) of (h) orce Account - Misc. (10 to 15%) of (h) orce Account - Misc. (10 to 15%) of (h) orce Account - Misc. (10 to 15%) of (h) orce Account - Misc. (h+i+j) otal Construction Cost (h+i+j) otal Construction Engineering 17% of (k) otal Preliminary Engineering 15% of (k) otal Preliminary Engineering 0	Carrie \$8,854,483.21	(G)
Image: construction of the second	USA:	
proe Account - Utilities (1 to 2%) of (h) 2.00% Ca Default = 2% 12.00% Ca Default = 2% 12.00% Ca Default = 12% 12.00%	\$135,347,100.46	(H)
Default = 2% Default = 2% Dree Account - Misc. (10 to 15%) of (h) 12.00% Default = 12% 12.00% Cr ubtotal of Construction Cost (h+i+j) 17.00% Cr otal Construction Engineering 17% of (k) 17.00% Cr otal Preliminary Engineering 15% of (k) 15.00% Cr ght of Way Project Dependent N/A 15.00% Cr jillies Project Dependent N/A 0 0 0	\$100,041,100.40	
Default = 2% Default = 2% Default = 2% 12.00% Default = 12% 12.00% ubtotal of Construction Cost (h+i+i) otal Construction Engineering 17% of (k) otal Preliminary Engineering 15% of (k) ubtotal of Way Project Dependent Utilities Project Dependent Tunnel (Twin Tunnels) 15000 Interchanges 1	Carrie \$2,706,942.01	
Default = 12% Interview ubtotal of Construction Cost (h+i+j) otal Construction Engineering 17% of (k) otal Preliminary Engineering 15% of (k) otal Preliminary Engineering 15% of (k) otal Preliminary Engineering 15% of (k) otal Project Dependent 2.00% uitlies Project Dependent Tunnel (Twin Tunnels) 15000 Interchanges 0	\$2,700,942.01	()
Default = 12% Interview ubtotal of Construction Cost (h+i+j) otal Construction Engineering 17% of (k) otal Preliminary Engineering 15% of (k) otal Preliminary Engineering 15% of (k) otal Preliminary Engineering 15% of (k) otal Project Dependent 2.00% uitlies Project Dependent Tunnel (Twin Tunnels) 15000 Interchanges 0	Carrie \$16,241,652.06	
Datal Construction Engineering 17% of (k) 17.00% Ca Datal Preliminary Engineering 15% of (k) 15.00% Ca ght of Way Project Dependent 2.00% jitties Project Dependent N/A	Game \$10,241,032.00	(J)
Datal Construction Engineering 17% of (k) 17.00% Ca Datal Preliminary Engineering 15% of (k) 15.00% Ca ght of Way Project Dependent 2.00% jitties Project Dependent N/A	\$154,295,694,52	(K)
otal Preliminary Engineering 15% of (k) 15.00% Ca ight of Way Project Dependent 2.00% bilities Project Dependent N/A Tunnel (Twin Tunnels) 15000 0 Tunnel (South Bore EJMT) 30000 0 Interchanges 1 0	(STATION OF THE STATE OF THE ST	
ight of Way Project Dependent 2.00% ilities Project Dependent N/A Tunnel (Twin Tunnels) Tunnel (South Bore EJMT) Interchanges 1000 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Carrie \$26,230,268.07	(L)
ight of Way Project Dependent 2.00% ilities Project Dependent N/A Tunnel (Twin Tunnels) Tunnel (South Bore EJMT) Interchanges 1000 0 100 0 0 0 0 0 0 0 0 0 0 0 0 0 0	2053	
Initial South Bore EJMT) 15000 0 Interchanges 1 0	Carrier \$23,144,354.18	(M)
Ilities Project Dependent N/A Tunnel (Twin Tunnels) 15000 0 Tunnel (South Bore EJMT) 30000 0 Interchanges 1 0		
Ilities Project Dependent N/A Tunnel (Twin Tunnels) 15000 0 Tunnel (South Bore EJMT) 30000 0 Interchanges 1 0	\$2,706,942.01	(N)
Tunnel (Twin Tunnels) 15000 0 Tunnel (South Bore EJMT) 30000 0 Interchanges 1 0	#2,100,342.01	(12)建筑建筑
Tunnel (South Bore EJMT) 30000 0 Interchanges 1 0 1	1963	(O)
Interchanges 0	\$0.00	
	\$0.00	
Electrification 1 60500000	\$60,500,000.00	
Total Segment Cost	\$266,877,258.78	(P)

Estimate Worksheet		and the second	Control Parts			100 E	
	% Range		% Used	S. Constant		NEW YOR	
Stated Assumptions						Marchine year Marchine year	
					2475	ECHINAL COL	
Project Construction Items Item Description	Quantity	Per Unit Cost			0	121209-0057	
Structures (SF)	Quantity	150		1	Cost \$0.00		+
Walls (SF)	0	90	1.	C de la	\$0.00		
Earthwork (CY) Pavement (TON)	0	20			\$0.00		
Base Course (CY)	0	70			\$0.00	S	
Barrier (Type 7)(LF)	0	60	1 Anton	Carton In	\$0.00		-
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0	200			\$0.00		
Tunnel (South Bore EJMT) (LF)	0	30000			\$0.00	43.0.4	-
Interchanges (EACH)	0	1		建造的	\$0.00	A CONTRACTOR	
Monorall Structure Monorall Guideway	0 3168	4000			\$0.00		
Maintenance Facilities	3100	500			\$1,584,000.00		
Mobile MaIntenance Equipment				C CON			
Signals and Controls Stations/Parking (Large)	2	1200000		ALC:	\$2,400,000.00	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	
Stations/Parking (Large)	0	1000000.00			\$0.00	100	
Station/Parking (Small)	2	3000000.00	CT B PY		\$6,000,000.00	alle all a	
Fare Collection (Fare Vending Machines) General Engineering (LS)	3	37000.00			\$111,000.00	The Report	
		5020000	6	1 State	\$5,020,000.00	CONCERNENCES	
Total accounted construciton items					\$15,115,000.00	(a) Carrie	d to Sheet
			A STATE				
	The second second		Self to the lot is a	i la contra c		》(1995年2月75日) (1995年1月1日)	
Contingencles	(15% - 30%) of (A)	- meen	30.00%	Carrie	\$4,534,500.00	(B)	
Establised as a percentage			CEL GMEN				
S	(6-10%) of (a+b)		0.00%	Carrie	\$0.00	(C)	
	Default = 6%					Carl Carl	
Drainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrier	\$1,964,950.00	(0)	_
	Default = 6%		10.00 /2	Camer	\$1,904,930.00	(D)	-
Neping and Objetus	14 ENL 14		6.4.5				
Igning and Striping	(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$216,144.50	(E)	_
			1 1 200	18.18		1 22 152	-
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+	e)	7.00%	Carrie	\$1,528,141.62	(F)	
and the second se	Default = 20%	****	San State	C COLLEGE			
lobilization	(4 to 10%) of (a+b+c+d	+e+f)	7.00%	Carries	\$1,635,111.53	(G)	
	Default = 7%			1000		35.35 K	
			Constant State	C SECOND			
otal of Construction Items	(a+b+c+d+e+f+g)		· · · · · · · · · · · · · · · · · · ·	非关系的	\$24,993,847.64	(H)	
			26.000/088				_
orce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrie	\$499,876.95	(1)	
	Default = 2%		SECOND. S		<u>• •••• •• •••</u>	all and a second	
orce Account - Misc.	(10 to 15%) of (h)		12.00%		\$2,000,264,72		_
5165715552()(11165.	Default = 12%		12.0070	Сагтіе	\$2,999,261.72	(J)	+
				A REPART		(Helling ()	_
ubtotal of Construction Cost	(h+l+j)			Call B	\$28,492,986.31	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$4,843,807.67	(L)	-
					+ .je injoni.01		
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$4,273,947.95		
			13.00%	Carne	\$4,213,941.95	(M)	
			AL COMPANY				
ght of Way	Project Dependent		2.00%	COLUMN STATE	\$400 876 OF		
			2.6公務部	STREET.	\$499,876.95	(N)	
littes	Project Dependent		N/A	SAMT		(0)	
Tunnel (Twin Tunnels)	15000	0	17/15/2010 - 14-1 17/15/2010 - 14-1	10000 m	\$0.00	KALER	
Tunnel (South Bore EJMT)	30000			0613 1/	\$0.00	11111	
Interchenges	2-385-345-665-6688-2691	0	STATISTICS.	9.95 片	\$0.00	國和自	
Flocking							
Electrification	1	3000000		1	\$3,000,000.00		

Estimate Worksheet						ALL STATES	
	% Range		% Used			Contain State	
Stated Assumptions						State of Control of Co	
Project Construction Items						Called States	
Item Description	Quantity	Per Unit Cost	新学会的	Station of Cont	Cost		
Structures (SF) Walls (SF)	0	150			\$0.00 \$0.00		
Earthwork (CY)	0	20	D there in a		\$0.00		
Pavement (TON) Base Course (CY)	0				\$0.00 \$0.00	elen ele-	
Barrier (Type 7)(LF)	0	60	5		\$0.00	2 I K	
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0	200		1444	\$0.00 \$0.00		
Tunnel (South Bore EJMT) (LF) Interchanges (EACH)	0	30000	- CONTRACTOR (1997)		\$0.00		
Monorall Structure	0	4000	PARTICIPACITY CONTRACTOR		\$0.00 \$0.00		
Monorail Guideway MaIntenance Facilities	12144	500			\$6,072,000.00		
Mobile Maintenance Equipment	0				\$0.00		-
Signals and Controls Stations/Parking (Large)	2	1200000		(計畫)	\$2,400,000.00 \$10,000,000.00		
Stations/Parking (Medium)	2	600000.00			\$12,000,000.00		
Stations/Parking (Small) Fare Collection (Fare Vending Machines)	0	3000000.00			\$0.00		
General Engineering (LS)	1	20000		1942	\$20,000.00	AND TRAC	
Total accounted construction items			In the second		\$32,231,000.00	(a) Carrie	d to Sheet (
		the same second s	Non-Rain			2.2.2.3.4.元中中	
			Cir Sin				
Contingencles Establised as a percentage	(15% - 30%) of (A)		30,00%	Carrie	\$9,669,300.00	(B)	
S	(6-10%) of (a+b) Default = 6%		0.00%	Cerrie	\$0.00	(C)	
Prainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$4,190,030.00	(D)	
			and the late				
igning and Striping	(1-5%) of (a+b+c+d) Default = 5%		1.00%	Carrie	\$460,903.30	(E)	
construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e		7.00%				
	Default = 20%	2	7.00 %	Сапіе	\$3,258,586.33	(F)	
lobilization	(4 to 10%) of (a+b+c+d+	e+D	7.00%	Carrie	\$3,486,687.37	(G)	
	Default = 7%		1.0070	- Contribution	40,400,007.07		
			CONTRACTOR OF				
otal of Construction Items	(a+b+c+d+e+f+g)	in second diago	10000		\$53,296,507.01	(H)	
		······		27 av			
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$1,065,930.14	()	_
			北京的社会问题				
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$6,395,580.84	(J)	
ubtotal of Construction Cost							
	(h+i+j)		- ASS PERIO		\$60,758,017.99	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$10,328,863.06	(L)	
and Destinations. Sectors when				- Arabaran			
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$9,113,702.70	(M)	
ght of Way	Project Dependent	- 11/1	2.00%		\$1,065,930.14	(N)	- indire-
lilities	Project Dependent		N/A	a langu bar			
			长年的目前 在1	19-74		(0)	
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	15000	<u>0</u> 0		A SERVICE	\$0.00 \$0.00		_
Interchanges Electrification	A REAL PROPERTY AND A REAL	0	·清朝國 公寓	100	\$0.00		
	1	4500000	A STATE		\$4,500,000.00	1.1	-
Total Segmen	Cost	In the second production of the	Sector Labor	ESE MARTINE	\$85,766,513.88	(P)	-

Estimate Worksheet						22. A.W.		
	% Range		% Used	1253		RES SA		-
Stated Assumptions								+
Project Construction items			- Tice - api	各科学员		NUL INCO		
item Description	Quantity	Per Unit Cost			Cost	6/2013 P. 2013		-
Structures (SF)	0	150		S HALL	\$0.00	Constant Providence		1
Walls (SF) Earthwork (CY)	481496	90			\$43,334,640.00		1	-
Pavement (TON)	0	20		ALL PROPERTY	\$7,349,060.00	Heras Re	9	-
Base Course (CY)	0	40			\$0.00			<u> </u>
Barrier (Type 7)(LF)	0	60			\$0.00	See. H	1	
Special Structures (SF) Tunnel (Twin Tunnels) (LF)	0	200		St. King	\$0.00	常的影响		
Tunnei (South Bore EJMT) (LF)	0	30000		1.0 1.1	\$0.00			+
interchanges (EACH)	0	1			\$0.00			
Monorali Structure (LF) Monorali Guideway (LF)	122900	4000	C. The star	-	\$491,600,000.00 \$97,416,000.00	行行的		
Maintenance Facilities		riable		131	\$31,025,320.00	新名 目以	1	+
Mobile Maintenance Equipment		1250000		H. BR	1250000	主动语		1.5
Signals and Controls	41	1200000		14-1-1-1-	\$60,170,000.00	1		373400
Stations/Parking (Large) Stations/Parking (Medium)	0	1000000.00 600000.00			\$0.00		<u></u>	228300
Station/Parking (Small)	0	300000.00			\$0.00			1
Fare Collection (Fare Vending Machines)	19	37000.00			\$703,000.00	自己的人们	1	
General Engineering (LS)	1	12100000		A PARAMETER	\$12,100,000.00	NU HAVEN		+
Total accounted construction items			Summer of the		\$750,948,020.00	(8)	Carried to	Sheet One
						(5)(5)(1))		
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carries	\$225,284,406.00	(B)		
								-
rs	(6-10%) of (a+b) Default = 6%		0.00%	Carrie	\$0.00	(C)		-
			1751112	e men				1
Prainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carrie	\$97,623,242.60	(D)		
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$10,738,556.69	(E)		
-	Default = 5%				¢101.301000.03			
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e) Default = 20%		7.00%	Carrie	\$75,921,595.77	(F)		
Iobilization	(4 to 10%) of (a+b+c+d+e	i+f)	7.00%	Carrie	\$81,236,107.47	(G)		
	Default = 7%							
otal of Construction Items	(a+b+c+d+e+f+g)				\$1,241,751,928.53	(H)		
orce Account - Utilities	(1 to 2%) of (h) Dafault = 2%		2.00%	Carrie	\$24,835,038.57	(I)		
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$149,010,231.42	(J)		
ubtotal of Construction Cost	(h+i+j)				\$1,415,597,198.52	(K)		
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$240,651,523.75	(L)		-
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$212,339,579.78	(M)		
				and				
lght of Way	Project Dependent		2.00%		\$24,835,038.57	(N)		
tilities	Projact Dependent		N/A			(O)	-	
Tunnei (Twin Turineis) Tunnei (South Bore EJMT)	15000	0		2517	\$0.00	A Part		
interchanges	30000	0	Service States	Constant of	\$0.00			
Electrification	a source of the	81500000	Max Lines	SURFERING.	\$81,500,000.00			

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	9/ Dance		0/ 11-0-1			8 _ H = = = = = = = = = = = = = = = = = =	
	% Range	1.0	% Used			<u>- 19 780</u> - 19 - 18 00	
Stated Assumptions			34.21	San and a second		13-15	
			addin Sile			S. R. L.	
Project Construction items	0	D 11 10 1	ELESSO			大学が	
Item Description Structures (SF)	Quantity 0	Per Unit Cost 150	ALL DESIGN AND ALL DESIGNATION OF THE PARTY	AC THE LEVEL	Cost \$0.00		
Walls (SF)	0	90			\$0.00	12.23	
Earthwork (CY)	0	20			\$0.00		
Pavement (TON)	0	70			\$0.00	16	
Base Course (CY) Barrier (Type 7)(LF)	0	40			\$0.00 \$0.00		
Special Structures (SF)	0	200			\$0.00	AL MALS	
Tunnel (Twin Tunnels) (LF)	0	15000			\$0.00		
Tunnel (South Bore EJMT) (LF)	0	30000			\$0.00		
Interchanges (EACH) Monorall Structure (LF)	0	4000			\$0.00		·
Monorall Guideway (LF)	15840	500		到25%百一十	\$63,360,000.00 \$7,920,000.00		
Maintenance Facilities	0	0			\$0.00	行行的法	
Mobile Maintenance Equipment	0	0	Line and the second second	調化	\$0.00		
Signals and Controls Stations/Parking (Large)	0	1200000			\$0.00		
Stations/Parking (Medium)	0	6000000.00			\$0.00 \$0.00		
Station/Parking (Smali)	0	3000000.00			\$0.00	11.25	
Fare Collection (Fare Vending Machines)	9	37000.00		The London Sta	\$333,000.00	人们也是自己了	
General Engineering (LS)	1	5600000	And Andrews		\$5,600,000.00	PER MAIN	
Total accounted construciton items			Contrast in		\$77,213,000.00	(a)	Carried to Sheet O
				THE REAL	\$17,210,000.00	NAL ISSUE	Carned to Sheet Of
		6-14-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	1.20.24			(1)等的(1)等的	
0						NUT ARE	
Contingencies Establised as a percentage	(15% - 30%) of (A	V	30.00%	Carried to	\$23,163,900.00	(B)	
Establised as a percentage			12-14-5-26			Said I	
ITS	(6-10%) of (a+b)	· · · · · · · · · · · · · · · · · · ·	0.00%	Carried to	\$0.00	(C)	
	Default = 6%			CHEN LONG			
Drainage/Water/Sewer	12 100/ 206 (014)		1000		£40.007.000.00	(1994)	
Drainage/water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Carried to	\$10,037,690.00	(D)	
			建制品品质制	SEE STREET		1.2.7	
Signing and Striping	(1-5%) of (a+b+c+	d)	1.00%	Carried to	\$1,104,145.90	(E)	
	Default = 5%		日本民族文言			n gina	
Construction Signing & Traffic Control	5 to 25% of (a+b+	(a+b+c	7.00%	Carried to	\$7,806,311.51	(F)	
sensa action originary or manife control	Default = 20%	crurej	1.0070	Camed to	\$1,000,311.31	(-)	
			Research State				
Mobilization	(4 to 10%) of (a+b	+c+d+e+f)	7.00%	Carried to	\$8,352,753.32	(G)	
	Default = 7%			Contract of			
			a statistical				
Total of Construction items	(a+b+c+d+e+f+g)		新新教 制		\$127,677,800.73	(H)	
				Stat 1			
Force Account - Utilities	(1 to 2%) of (h)		2.00%	Carried to	\$2.553.556.01	-	
	Default = 2%		2.0076	Camed to	\$2,555,556.01	(1)	
			H. C. S.	SULER AND		1	
Force Account - Misc.	(10 to 15%) of (h)		12.00%	Carried to	\$15,321,336.09	(J)	
	Default = 12%					a solo	
Subtotal of Construction Cost	(h+i+j)		1335 V 15 18 18	Aprent State (1)	\$145,552,692.83	(K)	
				Real States		Bann	
Total Construction Engineering	17% of (k)		17.00%	Carried to	\$24,743,957.78	(L)	
			Part Sectorize	Ser Constant		Sector -	
Total Preliminary Engineering	15% of (k)		15.00%	Carried to	\$21,832,903.93	(M)	
			Constant of	VC. PSSID			
			A STATE OF THE STA				
Right of Way	Project Dependent		2.00%		\$2,553,556.01	(50)	
	, rojoor Dependen			14362 5-554	ψεισσισσιστ	(N)	
Jtilities	Project Dependent		N/A	Section 1		(0)	
	AN CONTRACTOR AND ADDRESS		CASE PYSE	20110282112	and the second se	State A	
Funnel (Twin Tunnels) Funnel (South Bore EJMT)	15000	0		またに対応時代 し かないので、いる。 か	\$0.00		<u>├</u>
nterchanges	1	0		Contractor of	\$0.00		├ <u></u>
Electrification	1	8300000		Space Alexand	\$8,300,000.00		
			All and a second second	AND CONTRACTOR			

2025	Winter
	no IMC
	cents per mile
	minute peak headways
10	minute off-peak headways
10	minute on-peak neadway
Feeder Bus CB1, Westbound	
Station	AM Ons
US 6 / Gaming	1263.596
Blackhawk	47.515
Central City	41.010
Line Totals	1311.111
	1311.111
Feeder Bus CB1, Both Directions	
Station	AM Ons
Central City	46.7
Blackhawk	353.379
US 6 / Gaming	1263.596
Line Totals	1663.696
	1003.090
Feeder Bus WP, Eastbound	
Station	AM Ons
Winter Park	587.304
Empire Station	001.004
Line Totals	587.304
Feeder Bus WP, Westbound	
Station	AM Ons
Empire Station	2049.224
Winter Park	
Line Totals	
	2049.224
Feeder Bus WP, Both Directions	2049.224
Feeder Bus WP, Both Directions	
Feeder Bus WP, Both Directions	AM Ons
Feeder Bus WP, Both Directions Station Winter Park	AM Ons 587.304
Feeder Bus WP, Both Directions	AM Ons 587.304 2049.224
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals	AM Ons 587.304 2049.224
Feeder Bus WP, Both Directions Station Winter Park Empire Station	AM Ons 587.304 2049.224
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station	AM Ons 587.304 2049.224 2636.528 AM Ons
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta	587.304 2049.224 2636.528
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR Line Totals Feeder Bus MT, Westbound	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222 894.321
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR Line Totals Feeder Bus MT, Westbound Station Station	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222 894.321
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR Line Totals Feeder Bus MT, Westbound Station Arapahoe pnR	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222 894.321 AM Ons 1857.344
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR Line Totals Feeder Bus MT, Westbound Station Arapahoe pnR Mineral Sta	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222 894.321 894.321 AM Ons 1857.344 1359.418
Feeder Bus WP, Both Directions Station Winter Park Empire Station Line Totals Feeder Bus MT, Eastbound Station Jefferson Mineral Sta Arapahoe pnR Line Totals Feeder Bus MT, Westbound Station Arapahoe pnR	AM Ons 587.304 2049.224 2636.528 AM Ons 894.098 0.222 894.321 AM Ons 1857.344

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Δ	G	Т	

	Fare Card	Machines								
EB	Peak Fare	Feeder	Peak-	Per	2	Fare		Adjust for	Machines at	
Station	Purchase	Bus	Feeder	Hour	minute	Machine	Rounded	min	Other Locations	Tota
DIA	1244	0	1244	311	622	10.4	11	11	4	15
DUSDenver Metra	No ridership					6.0	6	6	24	30
Stapleton	4807	0	4807	1202	2404	40.1	41	41	2	43
Jefferson	5681	1003	4678	1169	2339	39.0	39	39	5	44
El Rancho	670	0	670	168	335	5.6	6	6	1	7
US 6/Gaming	341	325	16	4	8	0.1	1	2	1	3
Idaho Spgs	195	0	195	49	98	1.6	2	2	1	3
Empire Jct	701	637	64	16	32	0.5	1	2	2	4
Georgetown	109	0	109	27	55	0.9	1	2	1	3
Loveland Ski	112	0	112	28	56	0.9	1	2	1	3
Silverthome TC	1130	0	1130	283	565	9.4	10	10	1	11
Frisco TC	3138	0	3138	784	1569	26.1	27	27	4	31
Copper Mtn	426	0	426	107	213	3.6	4	4	1	ŧ
Vail TC	2049	0	2049	512	1024	17.1	18	18	1	19
West of Vail									9	
							Totals	172	58	230

Assumptions

Peak fare purchase was based on the sum of AM ons in both directions for winter Saturday.

There will be a minimum of 2 machines at every station.

Riders will purchase round trip tickets.

It takes 2 minutes for tourists to use machines.

Tickets and passes will be sold off location at convenient stores and the like.

Feeder bus users will have already purchased through tickets at resorts of other off site locations.

Assume 20% of ridership at Jefferson, Frisco, and Vail have passes

Other locations includes: All Denver Metra Stations, Pena, Cold Springs, Westminster, Arvada, Ward RD, Tech CTR., Mineral Springs, Casinos, Winter Park, Keystone, Arapahoe Basin, Breckenridge, Vail Lionhead, Avon, Edwards, Eagle, Village, Eagle Airport, Gypsum, Dotsero, and Glenwood Springs. It is assumed that all areas with a rail station will have at least one off site ticketing location at a retail location. Those machines have been added to the closest rail station location in the table. Resorts will also have fare card machines, also included here.

time factor in minute 2 Total cost \$ 8,658,810.00

Monorail Total Facilities Costs

Project Construction Items				
Item Description	Quantity	- 1	Per Unit Cost	Cost
Square foot indoor space	269,696.00	\$	115.00	\$31,015,040.00
Track needed (TF)	40,857.60	\$	150.00	\$6,128,640.00
Turnouts	94.00	\$	75,000.00	\$7,050,000.00
Transfer Table Structure	1.00	\$	500,000.00	\$500,000.00
			Sub total	\$44,693,680.00
Equipment				
Jacks	15	\$	75,000.00	\$1,125,000.00
Mechanical Washer	2	\$	200,000.00	\$400,000.00
			Sub total	\$1,525,000.00
			Total	\$46,218,680.00
Mobile Maintenance Equipment				
Inspection and service car	1	\$	3,000,000.00	\$3,000,000.00
Maintenance cars	2	\$	2,500,000.00	\$5,000,000.00
Snowplows	2	\$	300,000.00	\$600,000.00
Maintenance trucks, per track mile	83	Ŝ	8,000.00	\$664,000.00
······, p ······		•	Sub total	\$9,264,000.00
			Total	\$55,482,680.00
Passenger Railcar Fleet	190	\$	4,322,500.00	\$821,275,000.00
			Total	\$876,757,680.00

Assumptions Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail).

Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA Standards.

Heavy track maintenance will be contracted. Full capacity for snow removal and overhead wire maintenance will be provided. Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

lity: inspection, light maintenance and rd capacity for 80% of the rolling stock. Quantit Indoor Space 87 Undoor Space 1000000000000000000000000000000000000	308.00		
lity: inspection, light maintenance and rd capacity for 80% of the rolling stock. Quantit Indoor Space 87 uipment Items	308.00		
Ity: inspection, light maintenance and rd capacity for 80% of the rolling stock. Quantit Indoor Space 87 uipment Items	308.00		
cleaning. Yard capacity for 80% of the rolling stock. Quantit Square Foot Indoor Space 87 Guideway Turnouts Project Equipment Items	308.00		
Indoor Space 87 uipment Items	37,808.00	Price	
uipment Items		125	\$ 10,976,000.00
uipment Items	20428.8	150	\$3,064,320.00
8 9 10 Project Equipment Items	31.00	75000	\$2,325,000.00
9 10 Project Equipment Items			
10 Project Equipment Items			\$16.365.320.00
11 Jacks	5	75000	\$375.000.00
12 Mechanical Washer	-	200000	\$ 200,000.00
13		Total	\$ 575.000.00

a.

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-0				
1	Frisco Facility for Inspection. Overhaul. light and heavy maintenance			
4	and cleaning with yard capacity for 40% of the fleet	Quantity	Per Unit Cost	Cost
5	Square Foot Indoor Space	150,528.00	125 \$	\$ 18,816,000.00
ø	Guideway	10214.4	150	\$1,532,160.00
~	Turnouts	16.00	75000	\$1,200,000.00
8	Transfer Table Structure	4	500000	\$500,000.00
6			sub	\$22,048,160.00
0	10 Project Equipment Items			
-	11 Item Description	Quantity	Per Unit Cost	Cost
2	12 Jacks	10	\$ 75,000.00	\$ 750,000.00
3	13 Shop car mover	-	\$ 300,000.00	\$ 300,000,00
14				
15				
	Shop sized for six 3 car units. Additional 60% sqare footage indoor space for car washer, parts warehouse, craft	indoor space for	car washer, parts	warehouse, craft
	shop, storage of maintenance trucks, administrative offices (including dispatch office), SCADA Control Center,	including dispate	th office), SCADA	Control Center,
ω	16 traffic control center, training room, and locker facilitites and commissary.	commissary.		
æ				

\$1,532,160.00 \$3,525,000.00 \$8,977,160.00 3,920,000.00 200,000.00 9,177,160.00 Shop sized for one 5 car unit. Additional 100% square footage for ancilary facilities including Δ Per Unit Cost | Cost 200000 \$ Э θ 125 150 75000 C Total Price 10214.4 47.00 31,360.00 Quantity മ Quantity 4 cleaning with yard capacity for 40% of the fleet 3 Vail Facility for light car maintenance and 17 car washer and commissary. 11 Project Equipment Items 6 Square Foot Indoor Space ∢ 13 Mechanical Washer 12 Item Description 7 Guideway 8 Turnouts 44 15 16 10 S თ 2

9,520,000.00 136,000.00 10,492,416.00 475,200.00 1,760,000.00 272,000.00 1,088,000.00 207,267,292 41,453,458 472,158.72 157,386.24 175,549,440.00 300,000,000.00 7,344,691.20 248,720,751 TOTAL COSI θ Э θ θ Э Э Э 3,570,000.00 178,200.00 65,831,040.00 660,000.00 102,000.00 408,000.00 2,754,259.20 177,059.52 59,019.84 51,000.00 3,934,656.00 Cost Rounded to LABOR COST ю ω ω θ θ 6 98,366.40 70,000.00 680,000.00 4,590,432.00 295,099.20 5,950,000.00 85,000.00 6,557,760.00 297,000.00 109,718,400.00 1,100,000.00 Cost Rounded to TOT. UNIT COST SUBTOTAL 20% CONT ω ω Э θ Э Э S 10,000 40,000 5000 3000 200 200 200 18,480 45 15 350000 3000 UNIT COST 5,500 6,558 6,558 2,186 66 0 RATE UNITS REQ. 248 548,592 139,920 17 1 **ო ო** ო 4 1/200' T Entire route Cat pole Cat pole Substa. Substa. Mile Ба Ea. ша Ша ដដដ Catenary System Mainline Contact rails & supports Circ. Brk. Auto Reclose 10000 KVA Substation **TEM DESCRIPTION** Catenary Poles XO Cat Sys. Passing 12 KV insulators Auto. Tie Switch Catenary Poles 12 KV Spacers Cat. Sys. XO 12 KV Wire Summary SCADA

Rail

Miles	82.8
Feet	437184
Track feet	688512
Substations	17
Crossovers	11
Passing sidings	2
length of each siding (ft)	24.3 mi
length of single track section	128304 ft
	12.6 mi
length of single track section	66528 ft

Assumptions

System Voltage = 25,000 v.a.c.

System Length = 82.8 miles

A.) Base Consist = 10 cars/train

B.) Base Energy required in KWH = 6,191 KWH

C.) Energy required in KVA = B.x1.38 = 8,544 KVA

Energy required one direction = CxD = 561,264 KVA D.) Number of consists required = E.) Energy required one direction =

F.) Energy required for both directions = 2xE = 102,528 KVA

Substations required(one/ stop+2) = 11 (j

H.) Substation KVA = F/G = 8,544 KVA

ITEM DESCRIPTIONUNITRATE UNITS12 KV WreMile312 KV WreMile312 KV InsulatorsCat pole312 KV SpacersCat pole312 KV SpacersCat pole312 KV SpacersCat pole312 KV SpacersCat pole312 KV SubstationEa3Auto. Tie SwitchEa1/200'Catenary PolesEa1/200'Contact rails & supportsFt4Contact rails XOFt4Contact rails XOFt4Cat Sys. PassingFt4SCADASubsta.4Circ. Brk. Auto RecloseSubsta.4	Jefferson Station-Hyland Hills				
Mile 3 Cat pole 3 Cat pole 3 Cat pole 3 Ea 1/200' Ea 1/200' Ft Ft Ft Ft Ft Substa. 4 cclose Substa. 4	RATE UNITS	S REQ. UNIT CO.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST		TOTAL COST
Cat pole 3 Cat pole 3 Cat pole 3 Ea. 1/200' Ea. 1/200' Ft Ft Ft Ft Substa. 4	m	40 18,	18,480 734580	440748	1175328
ation Ea Cat pole 3 Ea. 1/200' 1 Ea 1/200' 1 Ft Ft Ft Substa. 4 close Substa. 4	ŝ	1049	45 47223	28333.8	75556.8
ation Ea Ea. 1/200' Ea 1/200' Ft Ft Ft Substa. 4 A tclose Substa.	ŝ	1049	15 15741	9444.6	25185.6
Ea. Ea 1/200' Ft Ft Substa. close Substa. 4		7 35000	2450000	1470000	3920000
pports Ft 1/200' 1 Ft Ft Substa. 4 sclose Substa. 4		7 50	5000 35000	21000	56000
pports Ft Ft Ft Ft Substa. 4 cclose Substa. 4	·	350 31	3000 1049400	629640	1679040
sclose		139920	160 22387200	13432320	35819520
sclose		1000	200 200000	120000	320000
sclose		0	200 0	0	0
	4	7 10,0	10,000 70000	42000	112000
		7 40,0	40,000 280000	168000	448000
			SUBTOTAL	ω	43,630,630
			20% CONT	\$	8,726,126
				\$	52,356,756
			Cost Rounded to	Cost Rounded to \$	60,000,000

Assumptions System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Enerov required in KVA = B.x1.38 = 8.544 KVA				G.) Substations required(one/ stop+2) = 11	H.) Substation KVA = F/G = 8,544 KVA	I.) Double track with crossovers spaced 8 miles apart
	13.25	09669	139920	2	2	0
	Miles	Feet	Track feet	Substations	Crossovers	Passing sidings

Jeff-Hyl

	I I I I I I I I I I I I I I I I I I I							
ITEM DESCRIPTION	UNIT	RATE UNIT:	S REQ. U	NIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL	TOTAL COST
12 KV Wire	Mile	ę	40	18,480	734580		440748	1175328
12 KV Insulators	Cat pole	c	1049	45	47223		28333.8	75556.8
12 KV Spacers	Cat pole	с	1049	15	15741		9444.6	25185.6
10000 KVA Substation	Ea		ς	350000	105000	63	630000	1680000
Auto. Tie Switch	Ea.		с С	5000	15000		0006	24000
Catenary Poles	Еа	1/200'	350	3000	1049400	62	629640	1679040
Catenary Poles XO	Ea	11	33	3000	00066	5	59400	158400
Catenary System Mainline	Ft		139920	200	27984000	1679	16790400	44774400
Cat. Sys. XO	Ft		1500	200	300000	18	180000	480000
Cat Sys. Passing	Ft		0	200	0		0	0
SCADA	Substa.	4	n	10,000	30000	-	18000	48000
Circ. Brk. Auto Reclose	Substa.	1	3	40,000	120000	2	72000	192000
					SUBTOTAL		↔	50,311,910
					20% CONT		Ь	10,062,382
							\$	60,374,292
					Cost Rounded to	Cost Rounded to Cost Rounded to	ŝ	60,000,000

System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KWH = 6,191 KWH C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6 E.) Energy required one direction = CxD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA G.) Substations required(one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA I.) Double track with crossovers spaced 8 miles apart

Assumptions

13.25 69960 139920 3	000
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Miles Feet Track feet Substations Crossovers Passing sidings

Hyl-Emp

Segment	Empire Jct-Loveland	pu						
ITEM DESCRIPTION	UNIT	RATE UNI	TS REQ. L	INIT COST TC	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	Γ
12 KV Wire	Mile	r	20	18,480	914760	548856		1463616
12 KV Insulators	Cat pole	ო	1307	45	58806	35283.6		94089.6
12 KV Spacers	Cat pole	ო	1307	15	19602	11761.2		31363.2
10000 KVA Substation	Ea		~	350000	350000	210000		560000
Auto. Tie Switch	Ea.		-	5000	5000	3000		8000
Catenary Poles	Ea	1/200'	436	3000	1306800	784080		2090880
Catenary Poles XO	Ea	11	11	3000	33000	19800		52800
Catenary System Mainline	Ŧ		174240	200	34848000	20908800		55756800
Cat. Sys. XO	Ŧ		500	200	100000	60000		160000
Cat Sys. Passing	Ť		0	200	0	0		0
SCADA	Substa.	4	-	10,000	10000	6000		16000
Circ. Brk. Auto Reclose	Substa.		~	40,000	40000	24000		64000
				S	SUBTOTAL		\$ 60,297,549	549
				й	20% CONT		\$ 12,059,510	,510
							\$ 72,357,059	,059
				Ō	ost Rounded to	Cost Rounded to Cost Rounded to	\$ 70,000,000	000

Assumptions

System Voltage = 25,000 v.a.c. System Voltage = 25,000 v.a.c. System Length = 86.6 miles A.) Base Consist = 10 cars/train B.) Base Energy required in KVA = B.x1.38 = 8,544 KVA C.) Energy required in KVA = B.x1.38 = 8,544 KVA D.) Number of consists required = 6 E.) Energy required one direction = CXD = 561,264 KVA F.) Energy required for both directions = 2xE = 102,528 KVA G.) Substations required (one/ stop+2) = 11 H.) Substation KVA = F/G = 8,544 KVA I.) Double track with crossovers spaced 8 miles apart

> 16.5 87120 174240

0

Passing sidings

Substations Crossovers

Track feet

Miles Feet Emp-Love

Segment	Loveland-Tunnel	Inel						
ITEM DESCRIPTION	UNIT	RATE	UNITS REQ.	UNIT COST T	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	LT 10
12 KV Wire	Mile	с С	2	18,480	33264	19958.4		53222.4
12 KV insulators	Cat pole	Ϋ́	48	45	2138.4	1283.04		3421.44
12 KV Spacers	Cat pole	n	48	15	712.8	427.68		1140.48
10000 KVA Substation	Еа		~~	350000	35000	210000		560000
Auto. Tie Switch	Ea.		-	5000	5000	3000	0	8000
Catenary Poles	Еа	1/200'	16	3000	47520	28512		76032
Catenary Poles XO	Еа	1	11	3000	33000			52800
Catenary System Mainline	Ŧ		6336	200	1267200	760320		2027520
Cat. Sys. XO	Ť		500	200	100000	60009		160000
Cat Sys. Passing	Ť		0	200	0			0
SCADA	Substa.	4	~	10,000	10000	6000		16000
Circ. Brk. Auto Reclose	Substa.		1	40,000	40000	24000		64000
				0,	SUBTOTAL		\$ 3,02:	3,022,136
					20% CONT		\$	604,427
							\$ 3,62(3,626,564
				U	Cost Rounded to	Cost Rounded to Cost Rounded to	\$ 4.00(4.000.000

Assumptions	System Voltage = 25,000 v.a.c.	System Length = 86.6 miles	A.) Base Consist = 10 cars/train	B.) Base Energy required in KWH = 6,191 KWH	C.) Energy required in KVA = B.x1.38 = 8,544 KVA	D.) Number of consists required = 6	E.) Energy required one direction = CxD = 561,264 KVA	F.) Energy required for both directions = 2xE = 102,528 KVA	G.) Substations required(one/ stop+2) = 11	H.) Substation $KVA = F/G = 8,544 KVA$	 Double track with crossovers spaced 8 miles apart 	
						0.6	3168 -	6336	4	-	0	
						Miles	Feet	Track feet	Substations	Crossovers	Passing sidings	

Love-Tun

Segment	Eisenhower Tunnel							
ITEM DESCRIPTION	UNIT	RATE UNITS	REQ. U	NIT COST	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	LABOR COST	TOTAL COST	Γ
12 KV Wire	Mile	e	7	18,480	127512	76507.2	204019.2	19.2
12 KV Insulators	Cat pole	ო	182	45	8197.2	4918.32	13115.52	5.52
12 KV Spacers	Cat pole	ო	182	15	2732.4	1639.44	4371.84	1.84
10000 KVA Substation	Ea		0	350000	0	0		0
Auto. Tie Switch	Ea.		0	5000	0	0		0
Catenary mounting brackets	Ea	1/200'	61	3000	182160	109296		291456
Catenary Poles XO	Ea	11	0	3000	0	0		0
Catenary System Mainline	Ę		12144	200	2428800	1457280	3886080	0800
Cat. Sys. XO	Ft		0	200	0	0		0
Cat Sys. Passing	Ft		0	200	0	0		0
SCADA	Substa.	4	0	10,000	0	0		0
Circ. Brk. Auto Reclose	Substa.		0	40,000	0	0		Ö
					SUBTOTAL		\$ 4,399,043	043
					20% CONT		\$ 879,809	809
							\$ 5,278,851	851
					Cost Rounded to	Cost Rounded to Cost Rounded to	\$ 5,000,000	000

Assumptions

B.) Base Energy required in KWH = 6,191 KWH
C.) Energy required in KVA = B.x1.38 = 8,544 KVA
D.) Number of consists required = 6
E.) Energy required one direction = CxD = 561,264 KVA
F.) Energy required for both directions = 2xE = 102,528 KVA
G.) Substations required(one/ stop+2) = 11
H.) Substation KVA = F/G = 8,544 KVA A.) Base Consist = 10 cars/train System Voltage = 25,000 v.a.c. System Length = 86.6 miles I.) One track

12144 0 0 0

Passing sidings

Substations Crossovers

Track feet

Miles Feet

2.3 12144

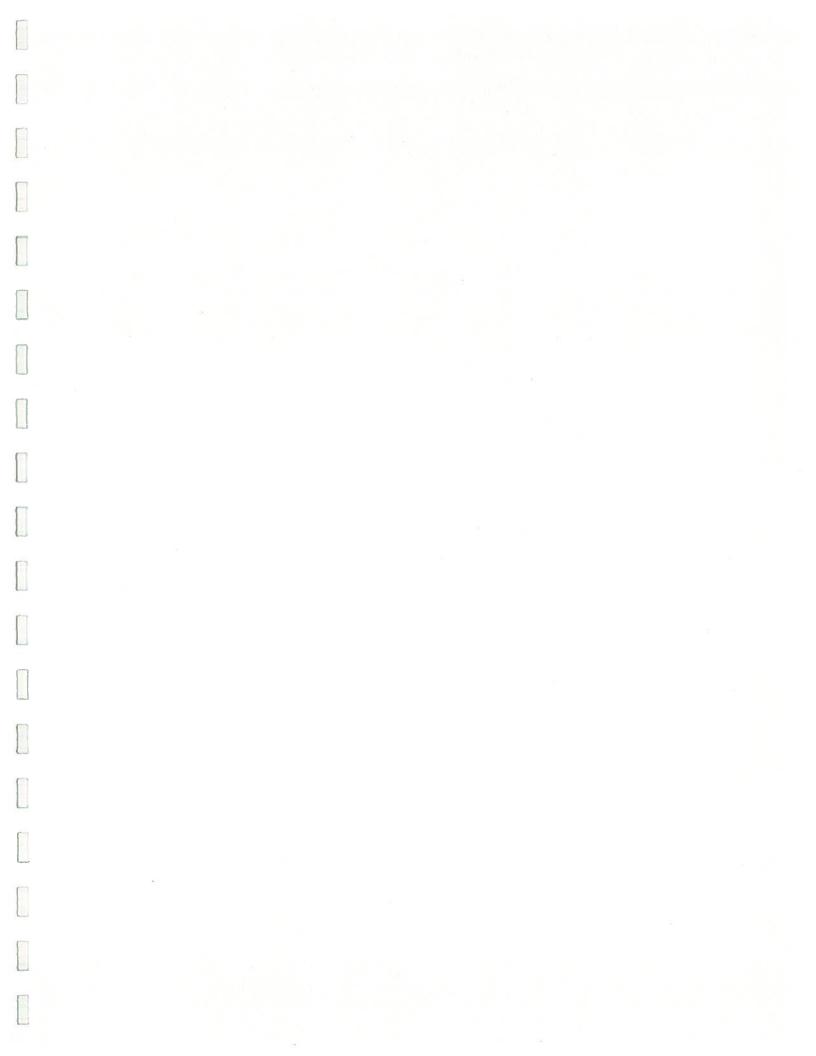
Ike Tunnel

Segment	Tunnel-Vail						
ITEM DESCRIPTION	UNIT	RATE UI	NITS REQ.	RATE UNITS REQ. UNIT COST TOT. UNIT COST LABOR COST	F. UNIT COST	LABOR COST	TOTAL COST
12 KV Wire	Mile	က	111	18,480	2045736	1227441.6	3273177.6
12 KV Insulators	Cat pole	ო	2922	45	131511.6	78906.96	210418.56
12 KV Spacers	Cat pole	с С	2922	15	43837.2	26302.32	
10000 KVA Substation	Ea		5	350000	1750000	105000	
Auto. Tie Switch	Ea.		5	5000	25000		
Catenary Poles	Ea	1/200'	974	3000	2922480	1753488	4675968
Catenary Poles XO	Еа	11	44	3000	132000	79200	
Catenary System Mainline	Ħ		215952	200	43190400	25914240	69104640
Cat. Sys. XO	Ъ		2000	200	40000	240000	
Cat Sys. Passing	Ρt		0	200	0		
SCADA	Substa.	4	5	10,000	50000	30000	80000
Circ. Brk. Auto Reclose	Substa.		َ ۲	40,000	20000	120000	en
				ns	SUBTOTAL		\$ 81,425,544
				20	20% CONT		\$ 16,285,109
							\$ 97,710,652
				ပိ	st Rounded to	Cost Rounded to Cost Rounded to	\$ 100,000,000

	e,		ion	ion
Rail Miles Feet	Track feet Substations	Crossovers Passing sidings	length of each siding (ft) length of single track section	length of single track section

Assumptions System Voltage = 25,000 v.a.c.	System Length = 86.6 miles	A.) Base Consist = 10 cars/train	B.) Base Energy required in KWH = 6,191 KWH	C.) Energy required in KVA = B.x1.38 = 8,544 KVA	D.) Number of consists required = 6	E.) Energy required one direction = CxD = 561,264 KVA	F.) Energy required for both directions = 2xE = 102,528 KVA	G.) Substations required(one/ stop+2) = 11	H.) Substation KVA = $F/G = 8,544$ KVA	I.) Double track with crossovers spaced 8 miles apart
36.9	194832	215952	5	4	7	10,560	24.3 mi	128304 ft	12.6 mi	66528 ft

Tun-Vail



Truncated Diesel Bus (Transitway) Estimate R1

ID ITEMS	COST PER UNIT	QUANTITY	COST		
Structures	150.00	0	0.00		
Walls	90.00	0	0.00		
Earthwork	20.00	0	0.00		
Pavement	70.00	0	0.00		143
Base Course	40.00	0	0.00		_
Barrier	60.00	0	0.00		
Special Structures	200.00	0	0.00		
Tunnel (Twin Tunneis)	15000	0	\$0.00		
Tunnel (South Bore EJMT)	30000	0	\$0.00		
interchanges	0	0	\$0.00		_
Maintenance Facilities	Variable	2	\$58,500,000.00		
Mobile Maintenance Vehicles	Variable	21	\$1,200,000.00	+	
Ramps for Busses	2000000	6	\$12,000,000.00		_
Stations/Parking (Large)	1000000		\$10,000,000.00		
Stations/Parking (Medium) Station (Smail)	6000000	1	\$6,000,000.00		_
	3000000	4	\$12,000,000.00		
Fare Collection (Fare vending machines) Passenger Rollingstock	37000		\$4,366,000.00		
Automatic Vehicle Location System	325000	241	\$78,325,000.00	++	
Automatic Venicle Location System	2892000	1	\$2,892,000.00 185,283,000.00	+	
			105,285,000.00		-
	% Range		% Used	Cost	
oject Construction Bid Items (per segment)				#102 B66 000 00	
ump Sum Items				\$102,866,000.00	
roject Construction Bid items	Project Dependent		NA	\$82,417,000.00 \$185,283,000.00	U
	in roleor poperident			103,203,000.00	. (
ontingencies*	(15% - 30%) of (A)		30.00%	\$55,584,900.00	(
rs	(6-10%) of (A+B)		0.00%	\$0.00	((
	Default = 6%			40.00	
ralnage/Utilities	(3-10%)of (A+B)		10.00%	\$24,086,790.00	(0
	Default = 6%				
igning and Striping	(1 EW) of (ALBACAD)		- A NON	#F 000 000 00	
igning and outping	(1-5%) of (A+B+C+D) Default = 5%		2.00%	\$5,299,093.80	(1
	Delault - 3 %				
onstruction Signing & Traffic Control	5 to 25% of (A+B+C+I		10.00%	\$27,025,378.38	
	Default = 20%	0.0	10.5078	321,023,318.30	(#
		and the second second			
lobilization	(4 to 10%) of (A+B+C	+D+E+F)	7.00%	\$20,809,541.35	(0
	Default = 7%				in.,
otal of Construction Bid Items	(A+B+C+D+E+F+G)			\$318,088,703.53	()
				\$310,000,103.33	ų
			一位的法律规则不能不可能的法律的法律		
orce Account - Utilities	(1 to 2%) of (H)		2.00%	\$6,361,774.07	(
	Default = 2%				
orce Account - Misc.	(10 to 15%) of (H)		12.00%	\$38,170,644.42	(
	Default = 12%				
ubtatel of Canatavatian Cast			- A REAL AND AND A REAL AND A REA	6000 CD1 100	
ubtotal of Construction Cost	(H+I+J)		一方法的"任何"并不可能是是相比不可能已经	\$362,621,122.03	()
atal Canata atlan Englandan	170/ of (V)		17 MP		81
otal Construction Engineering	17% of (K)		17.00%	\$61,645,590.74	(
otal Preliminary Engineering**	15% of (K)		15:00%	\$54,393,168.30	()
Ight of Way	Project Dependent		2.00%	\$6,361,774.07	(1
tilities	Project Dependent		N/A	\$0.00	(0
	COST	QUANTITY		[]	
Tunnei (Twin Tunnels) (LF)	15000.00		00	0.00	
Tunnei (South Bore EJMT) (LF)	30000.00	0.		0.00	
interchanges (EACH)	0.00			0.00	
	CONTRACTOR OF A DESCRIPTION OF A DESCRIP	THE R. LEWIS CO., No. 10, NO.	A PARTY AND A PART	\$485,021,655.15	- (
tal Project Cost	and the second second			erioster 1,000.10	2003
tal Project Cost	The second se	A CONTRACTOR			35

Truncated Diesel Bus (Transitway) Estimate R1

Estimate Worksheet			Fact UNIT			14.00	
	% Range		% Used			10 10 10 K	
		-		APRIL P			
Stated Assumptions						194 - E-	
Project Construction Items			Contender and for	12.9		14.00-2	
item Description	Quantity	Per Unit Cost	an durain		Cost	N DESKIEN	0
Structures Walls	0	150 90		Contraction of the	\$0.00		
Earthwork	0	20		25 17 17 19 19 19 19 19 19 19 19 19 19 19 19 19	\$0.00	AC MUNICAL	
Pavement	0	70	Cher (Passa	STREET.	\$0.00	Caurd IN	
Base Course	0	40			\$0.00	12 - 16 - 3	
Barrier Special Structures	0	60 200			\$0.00 \$0.00		8
Tunnel (Twin Tunnels)	0	15000	PERMIT		\$0.00	15111	
Tunnel (South Bore EJMT)	0	30000			\$0.00	Station a	8
Interchanges Maintenance Facilities	0	0 \$0.00		en sinder	\$0.00 \$0.00	C.C.C.	
Ramps for Busses	2	2000000			\$4,000,000.00	Steres	7
Stations/Parking (Large)	0	10000000		在自然	\$0.00	法在政治的	1
Stations/Parking (Medium) Station (Small)	1	6000000 3000000			\$8,000,000.00	Contraction of the second	
Fare Collection	13	37000			\$3,000,000.00		6
Total accounted construction items				T STAN	\$13,481,000.00	(a)	Carried to Sheet O
				L E L		以後常9/2	
			Contraction of the	1			
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrier	\$4,044,300.00	(B)	1
rs	(6-10%) of (a+b)		0.00%	Carrier	\$0.00	(C)	100
	Default = 6%		A CONTRACT				
Drainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrier	\$1,752,530.00	(D)	
· · · · · · · · · · · · · · · · · · ·	Defautt = 6%		2. C				
Signing and Striping	(1-5%) of (a+b+c+d)	- Internet of the	2.00%	Carrier	\$385,556.60	(E)	
ging no supra	Default = 5%				\$000,000.00	51553	
				THE REAL		(Carlos	1
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e Default = 20%)	10.00%	Carrier	\$1,966,338.66	(F)	
			美 传 也	(Sector			
Nobilization	(4 to 10%) of (a+b+c+d+	e+f)	7.00%	Carrie	\$1,514,080.77	(G)	
	Default ≃ 7%		201010				
							2
Total of Construction Items	(a+b+c+d+e+f+g)			32 SIS-	\$23,143,606.03	(H)	
						D. AL	
Force Account - Utilities	(1 to 2%) of (h)		2.00%	Carrier	\$462,876.12	(1)	0
	Default = 2%			1. 200325		The Martine	
Force Account - Misc.	(10 to 15%) of (h)		12.00%	CONTRACTOR OF	Fo 777 050 70		
Orde Account - Misc.	Default = 12%		12.00%	Carrier	\$2,777,256.72	(J)	
			防御御史後期中				
Subtotal of Construction Cost	(h+i+j)			1215	\$26,383,938.87	(K)	
otal Construction Engineering	17% of (k)	11 (14 H / 2 - 14 H / 2	17.00%	Carrier	\$4,485,269.61	(L)	
			N. S. S. A. S.	1 Section	•111001200.011	(-/	
otal Preliminary Engineering	15% of (k)		15.00%	Carrier	\$3,957,590.83	(M)	
			10,00%	C-almer	93,937,390.83	((M))	
			A STREET	A ZANTA		NG SI I	
Right of Way	Project Dependent		2.00%		\$462,876.12	(N)	
Itilities	Project Dependent		N/A	ALS N		(0)	
			the states	a salar		(0)	
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	15000	0	1054 (104)	2 102.05	\$0.00	民党	
interchanges	30000	0		1 1 3 3 4 1	\$0.00 \$0.00		
	1	too and all the states and the	分支制器	山市市市		自主物的	
Total Se	ament Cost	CONTRACTOR OF A	PROPERTY AND	35 18 C 19 19 19 19 19 19 19 19 19 19 19 19 19	\$35,289,675,43	(P)	

Estimate Worksheet				all the		
	% Range		% Used	1365		
				Part of		
Stated Assumptions			10-10-17 A			
Project Construction Items				4		
Item Description	Quantity	Per Unit Cost			Cost	
Structures	0	150	計画書	ALC: NO.	\$0.00	
Walls Earthwork	0	90			\$0.00	
Pavement	0	20	Carlos and	1. 法有一	\$0.00	
Base Course	0	40	日本的	S 219/11-	\$0.00	
Barrier	0	60			\$0.00	
Special Structures	0	200	新闻的 》	A CHARTER	\$0.00	
Tunnel (Twin Tunnels)	0	15000	相同的	后为高	\$0.00	
Tunnel (South Bore EJMT)		30000		APPLIT.	\$0.00	
Interchanges Maintenance Facilities		B40.000.000.00		Cilling .	\$0.00	
Ramps for Busses	2	\$42,000,000.00 2000000	学业中学生	5 - 5 D W	\$42,000,000.00 \$4,000,000.00	
Stations/Parking (Large)	1	1000000		383	\$10,000,000.00	
Stations/Parking (Medium)	0	6000000		川次主任	\$0.00	
Station (Small)	1	3000000	P. A.S.		\$3,000,000.00	
Fare Collection	49	37000	Neg Bri		\$1,813,000.00	
Total accounted construction items			in the set	N THE	\$60,813,000.00	(A)
				TRANK .		
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$18,243,900.00	(B)
Establised as a percentage				CELET BU	\$10,240,000.00	(0)
			11.			
S	(6-10%) of (a+b)		0.00%	Carrier	\$0.00	(C)
	Default = 6%			4284		
1			S AL	Call Call		
alnage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$7,905,690.00	(D)
	Default = 6%		(A	a shi tur		
aning and Striping	(1-5%) of (a+b+c+d)		2.00%	Carrie	\$1,739,251.80	(E)
	Default = 5%		le ar	ASS OF	\$1,705,201.00	(-)
Instruction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)		10.00%	Carrie	\$8,870,184.18	(F)
	Default = 20%			多自动		
bilization	(4 to 10%) of (a+b+c+d+e		7.00%	a server	FE 000 044 00	(0)
	Default = 7%	141)	1.00.7	Carrier	\$6,830,041.82	(G)
	- Donald The		1.11			
			王 王子子	1 States		
tal of Construction Items	(a+b+c+d+e+f+g)			diverse la	\$104,402,067.80	(H)
				Contraction of the		
rce Account - Utilities	(1 to 09/) - (//)		The state	A PERCENT		
ING PROVING Y UNRES	(1 to 2%) of (h) Default = 2%		2.00%	Carrier	\$2,088,041.36	(I)
	Delaut = 276				· · · · · · · · · · · · · · · · · · ·	
rce Account - Misc.	(10 to 15%) of (h)		12.00%	Carrier	\$12,528,248.14	(J)
	Default = 12%			Same -	*	()
			3-3-1			
btotal of Construction Cost	(h+i+j)		Call Call	102 5	\$119,018,357.29	(K)
tal Construction Engineering	179/ 05/13		12 0000	ALC: NO.	#00.000 +00 T	
ar consucción chymeening	17% of (k)		17.00%	Carrier	\$20,233,120.74	(L)
			121	THE ST		
tal Preliminary Englneering	15% of (k)		15.00%	Carried	\$17,852,753.59	(M)
			PHE P	CHERICA.		()
				A BARRE		
bt of Ma	Destant Dessards 1			1 1 1 1		
ht of Way	Project Dependent		2.00%	THE P	\$2,088,041.36	(N)
lities	Project Dependent		N/A			(0)
	in reject bependent		in the second	A CARE C		(0)
Tunnel (Twin Tunnels) (LF)	15000	0		and the second second second	\$0.00	
Tunnel (South Bore EJMT) (LF)	30000	0			\$0.00	
Interchanges (EACH)		0	-	Contraction of Contraction	\$0.00	
				ALC: NOT BEEN		

Truncated Diesel Bus (Transitway) Estimate R1

Estimate Worksheet				T. BARRAN		などの後の思想	
	% Range		% Used	A CONTRACT		A Section of the	
			Constant China	A HELEN		1081201213	
Stated Assumptions						Saurer	
Project Construction Items			Man Manager	to be added to		ALCORES .	
Item Description	Quantity	Per Unit Cost		R. History	Cost	2555	
Structures	0	150			\$0.00		
Walls Earthwork	0	90			\$0.00 \$0.00	H CARLEY U	
Pavement	0	70			\$0.00		
Base Course	0	40	an marked and		\$0.00	2 Call Control	
Barrier	0	60			\$0.00	「古法市場合」	
Special Structures Tunnel (Twin Tunnels)	0	200		S 442 404	\$0.00	: CATEN YES	
Tunnel (South Bore EJMT)	0	30000		1000	\$0.00 \$0.00	2017	
interchanges	0	0		1 PL STOR	\$0.00	F107.284 [25]	
Maintenance Facilities	1	\$18,500,000.00		1111	\$16,500,000.00		
Ramps for Busses	2	2000000			\$4,000,000.00		
Stations/Parking (Large) Stations/Parking (Medium)	0	1000000		Carlo In	\$0.00 \$0.00	n	
Station (Small)	2	300000			\$6,000,000.00		
Fare Collection	56	37000			\$2,072,000.00	With Set Like	
						New York Contraction	
Total accounted construction items				a sugar	\$28,572,000.00	(a)	anded to Physic
			2010		\$20,312,000.00		arried to Sheet
			22/11/2012			. Winter of	
A			Sheet P	5		12:04:00:0	
Contingencies Establised as a percentage	(15% - 30%) of (A)		30.00%	Carrier	\$8,571,600.00	(8)	
сачанает из и реговлиде			12-14-14 (A)	IN DEPENDEN		Association of	
"S	(6-10%) of (a+b)		0.00%	Carrier	\$0.00	(C)	
	Default = 8%		APACIGR 15	B Conta		19 19 19	
tente e a AM-to sta	10 1011 1 11 11		and a contraction of	3 12 12		10209	
rainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Cante	\$3,714,360.00	(D)	
	Detaut - 076		ISOACH SOL			· 第一日 -	
igning and Striping	(1-5%) of (a+b+c+d)		2.00%	Carrier	\$817,159.20	(E)	
	Default = 5%		电视时间 的				
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e		10.00%	Carrie	\$4,167,511.92	(F)	
	Default = 20%		10.00%	Carrier	34,107,511.92	-	
·····			MIRON AND PROVIDENT	2 1450			
lobilization	(4 to 10%) of (a+b+c+d+	e+f)	7.00%	Carrier	\$3,208,984.18	(G)	
	Default = 7%		STATE AND A STATE	24.200		-	
			AVSIL 47	Contractor		GARAGE-	
otal of Construction Items	(a+b+c+d+e+f+g)		CALCON AL	a state	\$49,051,615.30	(H)	
			(如何有)(2019)			法规国	
orce Account - Utilities	14 ha 00() = (()		2 000	A ALSON			
are new unit - Villues	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$981,032.31	(1)	
	Coldan - 2 /a		の時間にかってい	A DATE OF		1.000	
orce Account - Misc.	(10 to 15%) of (h)		12.00%	Carrie	\$5,886,193.84	(J)	
	Defauit = 12%		SBASSIE	1.8828			
ubtotal of Construction Cost	(balai)			Contraction of	\$55,916,841.44	00	
	(h+i+j)		NEW FALSE	A LOUGH	400,910,041.44	(K)	
otal Construction Engineering	17% of (k)	S. 11 2595418-19	17.00%	Салтен	\$9,506,203.04	(L)	
			R. C. T.			Alleriden	
otal Preliminary Engineering	459/ -7.03		COVERENT CODE	OF BERNEL	P0 007 000		
over i remining y Engineening	15% of (k)		15.00%	Салтен	\$8,387,826.22	(M)	
				000000	1	の形式の高	
			Constant in the	199702			
ight of Way	Project Dependent		2.00%	100	\$981.032.31	(N)	
tilities	Project Dependent		NA	1 01101		(0)	
	riget Dependent		Sector Party			(0)	
Tunnel (Twin Tunnels)	15000	stand the second	(BAR)	1021	\$0.00	N. P.	
Tunnel (South Bore EJMT)	30000	K		1213	\$0.00		
interchanges	A STATE OF A DESCRIPTION OF A DESCRIPTIO	0.5000000000000000000000000000000000000	Selection of the second	and street upon	\$0.00	A THEFT	
AND INTER AND A DECIDENT OF A	egment Cost		5 a (61	The second	\$74,793,903.01	101	
						CONTRACTOR OF STREET, ST.	

Diesel Bus in Transitway Total Facilities Costs

Project Construction Items Item Description	Quantity	Per Unit Cost	Cost
Square foot indoor space	586,161.56 \$	105.00	\$61,546,964.06
Miscellaneous Equipment and furnishings	Variable	Variable	\$1,350,000.00
			\$0.00
		Sub total	\$62,896,964.06
Mobile Maintenance Equipment			
Guideway double ended truck	2	400,000.00	\$800,000.00
Miscellaneous trucks	5 2	50,000.00	\$250,000.00
Toe Trucks	2 \$	100,000.00	\$200,000.00
Road Supervision (mini vans)	12 \$	30,000.00	\$360,000.00
		Sub total	\$1,610,000.00
		Total	\$64,506,964.06
Passenger Railcar Fleet	241.00 \$	325,000.00	\$78,325,000.00
Automatic Vehicle Location System	241.00 \$	12,000.00	\$2,892,000.00
		Subtotal	\$81,217,000.00
;		Total	\$208,620,928.13

Assumptions

Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail).

Passenger rolling stock does not include paratransit vehicles. The inter urban system is not required to operate ADA complimentary service and the buses are ADA compatible with lifts. However, the feeder bus will be required to offer complimentary service. Those costs Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA Standards.

Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

Automatic Vehicle Location System shall include equipment, office space and dispatch costs.

	A	8	U	D
2				
ო	Denver Facility: Heavy maintenance, cleaning, fueling,			
4	and adminstration.	Quantity	Price	
S	Square Foot Indoor Space	388,800.00	105	\$ 40,824,000.00
ဖ	Miscellaneous Equipment and furnishings	-	100000	\$1,000,000.00
~				\$0.00
∞				\$41,824,000.00
თ				
9				
7			Total	\$41,824,000.00
2	12 Shop sized to hold 80% of the fleet indoors with a 100% for administrative offices, fueling, and heavy	100% for admin	nistrative offices,	fueling, and heavy
13	13 Indoor space with the length of the Diesel bus, 45', width 8.5' and 14' lanes	and 14' lanes		

	Α	в	ပ	0
- 0				
30	3 Erisco Eacility for Instruction Overhaud light and heavy maintenance			
4		Quantity	Per Unit Cost	Cost
5		153,697.50	\$ 105.00	\$ 16,138,237.50
9	Miscellaneous Equipment and furnishings	-	\$ 250,000.00	\$ 250,000.00
1				ч Ф
8			sub total	\$ 16,388,237.50
၈	9 Project Construction Items			
18	10 Item Description	Quantity	Per Unit Cost	Cost
÷				۰ ب
9				•
33				•
4			Total	\$ 16,388,237.50
15			2	
9	16 An additional 15% was added to the floor space			

4,584,726.56 100,000.00 4,684,726.56 4,684,726.56 t ۵ Cost 105 \$ 100000 \$ θ θ θ Per Unit Cost C Total Total Price 1.00 43,664.06 Quantity മ Quantity 17 An additional 15% was added to the floor space 7 Miscellaneous Equipment and furnishings 3 Glenwood Facility for light car maintenance and 4 cleaning with yard capacity for 10% of the fleet **Project Construction Items** Item Description 4 6 Indoor Square Foot 10 12 13 4 15 16 11 œ 0 2 S

Truncated Diesel Bus (Guideway) Estimate R1

ID ITEMS	COST PER UNIT	QUANTITY	COST		
Structures	150.00	0	0.00	1	
Wails	90.00	0	0.00		
Earthwork	20.00	0	0.00		
Pavement	70.00	0	0.00		
Base Course	40.00	0	0.00		_
Barrier Special Structures	60.00	0	0.00		
Tunnei (Twin Tunneis)	200.00	0	0.00		-
Tunnel (South Bore EJMT)	15000	0	0.00		-
interchanges	0	0	0.00	++	-
Guided Busway Track	315	165528	\$52,141,320.00		
Maintenance Facilities	Variable	2	\$60,500,000.00		5
Mobile Maintenance Equipment	Variable	21	\$2,000,000.00		_
Ramps for Busses	2000000	6	\$12,000,000.00		-
Stations/Parking (Large)	1000000	1	\$10,000,000.00		
Stations/Parking (Medium)	6000000	1	\$6,000,000.00		1
Station (Smali)	3000000	4	\$12,000,000.00		1200
Fare Collection (Fare vending machines)	37000	118	\$4,366,000.00		
Passenger Rollingstock	325000	254	\$82,550,000.00		
Automatic Vehicle Location System	3048000	1	\$3,048,000.00		
tel			244,605,320.00		
			and the first in the second second second second		15
	% Range		% Used	Cost	
oject Construction Bib Items				\$157,007,320.00	
Imp Sum items				\$87,598,000.00	
roject Construction Bid items	Project Dependent		NA	\$244,605,320.00	(4
	-				
ontingencies*	(15% - 30%) of (A)		30.00%	\$73,381,596.00	(8
S	1011-111-0				6 H.
3	(6-10%) of (A+B)	and the second	0.00%	\$0.00	(0
	Default = 6%	n(\$\$)75			
rainage/Utilities	(3-10%)of (A+B)		10.00%	\$21 709 601 60	15
anageroance	Defauit = 6%		10,00%	\$31,798,691.60	(C
gning and Striping	(1-5%) of (A+B+C+D)		1.00%	\$3,497,856.08	(8
gring and outping	Default = 5%		1.00 8	\$3,497,000.00	(=
onstruction Signing & Traffic Control	5 to 25% of (A+B+C+D+	+E)	7.00%	\$24,729,842.46	(F
	Default = 20%		The second se		
oblization	(4 to 10%) of (A+B+C+E)+E+F)	7.00%	\$26,460,931.43	(G
	Default = 7%				181
otal of Construction Bid Items	(A+B+C+D+E+F+G)			\$404,474,237.56	()
			11、12、11、11、2、11、11、11、11、11、11、11、11、11		
prce Account - Utilities	(1 to 2%) of (H)		2.00%	\$8,089,484.75	(
	Default = 2%				
une Anneurat Mine					
prce Account - Misc.	(10 to 15%) of (H)		12.00%	\$48,536,908.51	(.
·	Default = 12%				
ubtotal of Construction Cost	AL.1. 0			A 101 100 000	17.
	(H+i+J)			\$461,100,630.82	(H
tal Construction Ecologorian	1701 - 1 // 1				
tal Construction Engineering	17% of (K)		17:00%	\$78,387,107.24	(L
tal Preliminary Engineering**	15% of (K)		15.00%	\$69,165,094.62	(N
				400,100,004.02	10
			A CONTRACTOR OF		
ght of Way	Project Dependent		2.00%	\$8,089,484.75	(N
MAL					
liities	Project Dependent		NA	\$0.00	(C
and the second					
Tunnol (Tude Tunnels) # EV	COST	QUANTITY		1	
Tunnel (Twin Tunnels) (LF) Tunnei (South Bore EJMT) (LF)	15000.00	0.	.00	0.00	
interchanges (EACH)	30000.00			0.00	
	0.00			0.00	
				A	
	THE STREET OF STREET	State of the state of the state	The second state of the second state of the second s	SR18 745 317 44	5 115
tal Project Cost				\$818,742,317,44	{ (I

Total Estimate

Drainage/Water/Sewer
Construction Signing & Tr Mobilization
Total of Construction Ite Force Account - Utilities
Force Account - Misc. Subtotal of Construction Total Construction Engine
Total Preliminary Enginee
Right of Way Utilities

Estimate Worksheet						
	% Range		% Used	S.S.S.		
Stated Assumptions			4 			
Stated Assumptions			编制了			
Project Construction items			En alter			
Item Description	Quantity	Per Unit Cost	2日		Cost	
Structures Walls	0	150			\$0.00	
Earthwork	0	90	いたが	- A.	\$0.00	
Pavement		20		14 A-	\$0.00	
Base Course	0	40	13200	CREEK!	\$0.00	
Barrier	0	60	R	All New	\$0.00	
Special Structures	0	200		1. Start	\$0.00	
Tunnei (Twin Tunnels)	0	15000	STR. IN LO	的复数形	\$0.00	
Tunnel (South Bore EJMT)	0	30000	記念的公		\$0.00	
Interchanges Gulded Busway Track	75240	0 315		为东西—	\$0.00	
Maintenance Facilities	/5240	\$42,000,000.00	C. C. L. C.	P. P. P.	\$23,700,600.00 \$42,000,000.00	
Ramps for Busses	2	2000000	- A CA	NG-INT	\$4,000,000.00	
Stations/Parking (Large)	1	10000000	ALC: N	刻取得	\$10,000,000.00	
Stations/Parking (Medium)	0	6000000			\$0.00	
Station (Smail)	1	3000000	D. Bandara		\$3,000,000.00	
Fare Collection	49	37000	Caller Ist		\$1,813,000.00	
Total accounted construction items				Sector State	\$84,513,600.00	(A
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$25,354,080.00	(B
Establised as a percentage						
	(6-10%) of (a+b)		0.00%	Carrie	\$0.00	(C
	Default = 6%			REN		1-
age/Water/Sewer	10 1001 1-11		之间是仍有	HERERA		63.5
age/water/oewer	(3-10%)of (a+b) Default = 6%		10.00%	Салтіе	\$10,986,768.00	(C
	Delaut - 6%		1			
ng and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$1,208,544.48	(E
	Default = 5%			Sarray.	¥1,200,011.40	1.
			N. SAL			
truction Signing & Traffic Control	5 to 25% of (a+b+c+d+e)		7.00%	Carrie	\$8,544,409.47	(F
and the second	Default = 20%		Sec. Ser			
lization	(4 to 10%) of (a+b+c+d+e		7.00%	THE REAL PROPERTY OF	*****	
	Default = 7%	+1 <u>]</u>	1.00%	Carrie	\$9,142,518.14	(G
			12.54			
				Stell State		
of Construction Items	(a+b+c+d+e+f+g)		这些 你		\$139,749,920.09	(H
			The state	0.00		
e Account - Utilities	(1 to 2%) of (h)		2.00%	Carrier	\$2,794,998.40	(1)
	Default = 2%		1220	13 第四日		
A				STATE:		
e Account - Misc.	(10 to 15%) of (h)		12,00%	Carrie	\$16,769,990.41	(J
	Default = 12%		1 Start	A GLIVA		
otal of Construction Cost	(h+i+j)		5.55		\$159,314,908.90	(K
			時期的		\$100,014,000.00	in
Construction Engineering	17% of (k)		17.00%	Carrier	\$27,083,534.51	(1
						11.2
Preliminary Engineering	15% of (k)		5.00%	Carrie	\$23,897,236.34	(M
				HEAL	AF010311500.04	(141
			封空	12.28		
of Way	Project Dependent		2.00%		\$2,794,998.40	(N
\$						
•	Project Dependent		WA.			(0
Tunnel (Twin Tunneis) (LF)	15000	0	Contraction of the local division of the loc	and particular	\$0.00	
Tunnel (South Bore EJMT) (LF)	30000	Ő			\$0.00	
interchanges (EACH)	1.	0_	See 34	din-st	\$0.00	

Truncated Diesel Bus (Guideway) Estimate R1

Estimate Worksheet			ESTOCIL			花的历	
	% Range		% Used			Vere of	
A			21			A. S. Content	
Stated Assumptions			al n wh			31443.86	
Project Construction Items			ANTERNA.				
Item Description	Quantity	Per Unit Cost		C. Carl	Cost	20,673	
Structures Walls	0	150			\$0.00	RUSSER	
Earthwork	0	90			\$0.00	ELCORDON	
Pavement	0	70	A STATE	a na a	\$0.00	TRATISAES	
Base Course	0	40		A Strange	\$0.00	State of the second sec	
Barrier Special Structures	0	60 200			\$0.00	ALL PAR	
Tunnel (Twin Tunnels)	0	15000		1. 100	\$0.00	CE (21.07%)	
Tunnel (South Bore EJMT)	. 0	30000	AND SITE	济级院	\$0.00	也论的公	
Interchanges	0 87120	0			\$0.00	政制的管理	
Guided Busway Track Maintenance Facilities	8/120	315 \$0.00	Contraction of	E TOPOT	\$27,442,800.00 \$0.00		
Ramps for Busses	2	2000000		ALC: NO	\$4,000,000.00	252031	
Stations/Parking (Large)	0	1000000			\$0.00	S Spiniski	
Stations/Parking (Medium) Station (Small)	1	6000000		an ann	\$8,000,000.00	N	
Fare Collection	13	3000000 37000	The second		\$3,000,000.00		
Total accounted construciton items		51000	The second	A DESS	\$40,923,800.00	(a)	Carried to Sheet O
		-		(Shar		FARMERS	
						小田山山	
Contingencles	(15% - 30%) of (A)		30.00%	Camie	\$12,277,140.00	(B)	
Establised as a percentage			and the second				
TS	(6-10%) of (a+b)	100 A 10	0.00%	Carrier	\$0.00	(C)	
	Default = 6%		0.007		40.00	(0)	
Drainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrier	\$5,320,094.00	(D)	
	Defautt = 6%				40,020,004.00	(0)	
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrie	\$585,210.34	(E)	
	Defauit = 5%			A STATE OF			1
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+a)	7:00%	Carrie	\$4,137,437.10	(F)	
	Default = 20%		2				
Nobilization	(4 to 10%) of (a+b+c+d+	e+f)	7.00%	Carrie	\$4,427,057.70	(G)	
	Default = 7%		A COLUMN TO A			the series	
			1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -				
fotal of Construction Items	(a+b+c+d+e+f+g)				\$67,870,739.14	(H)	
orce Account - Utilities			2.07	IF ISTAN			
	(1 to 2%) of (h) Default = 2%		2.00%	Carrier	\$1,353,414.78	(1)	
area Assault Mar						ANT R	
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrier	\$8,120,488.70	(J)	
	Delaur - 1276						
ubtotal of Construction Cost	(h+i+j)				\$77,144,642.63	(K)	
otal Construction Engineering	17% of (k)			HE GUSSII	*10.444 COO OF		
	17 / OT (K)		17.00%	Carrier	\$13,114,589.25	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrier	\$11,571,696,39		
	1378 OI (K)		10.00%	Came	\$11,571,686,39	(M)	
				24371	ł		
ight of Way	Project Dependent		2.00%	S Residence	\$1,353,414.78	(Ņ)	2
tilities	Project Dependent		N/A	0		(O)	
				a Seal		A Ish	
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	15000	0		Sole.	\$0.00		
Interchanges	30000	0	No Lorbrok	10.01	\$0.00	194 1853	
		U.S.	State Short	014483		10576-71	
Total Sec					\$103,184,343.05	(P)	

Truncated Diesel Bus (Guideway) Estimate R1

Estimate Worksheet			1. 192				
	% Range		% Used			The second	
						heatshe	
Stated Assumptions						- Marthal	
Project Construction items				1.11		A Station	
Item Description	Quantity	Per Unit Cost	ALL SHALL		Cost	MRANA HY	
Structures Walls	0	150 90			\$0.00 \$0.00	STATES STATES	
Earthwork	0	20			\$0.00	12232448	· · · · · · · · · · · · · · · · · · ·
Pavement	0	70	STATES	3 5 5 5 5	\$0.00	A IOMY	
Base Course	0	40			\$0.00	a series and	
Barrier Special Structures	0	60 200		AUTER OF	\$0.00 \$0.00		
Tunnel (Twin Tunnels)	ŏ	15000			\$0.00		
Tunnel (South Bore EJMT)	0	30000	Service 1	8 13 10 10	\$0.00	101230651	
Interchanges	0	0			\$0.00	学校的分发	
Guided Busway Track Malntenance Facilities	3168	315		A USED T	\$997,920.00 \$18,500,000.00		
Ramps for Busses	2	2000000			\$4,000,000.00	742.2 . (SAT &	
Stations/Parking (Large)	0	1000000			\$0.00	Na Radell	
Stations/Parking (Medium)	0	6000000			\$0.00	同語の時間	
Station (Small) Fare Collection	2 56	3000000 37000		Contraction in the	\$6,000,000.00 \$2,072,000.00	1000	
	30	37000		CO COLUMN	44,072,000.00	12-41-24-24	
Total accounted construction items		Second Second Second	1. non entr		\$31,569,920.00	s (a)	Carried to Sheet One
				U LAN	431,309,820.00	< 840 T	Carried to Sheet One
						ISPLANA NATIONA	
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$9,470,976.00	(B)	
Establised as a percentage				2000		品元批	
TS	(6-10%) of (a+b)		0.00%	Carrier	\$0.00	(C)	
13	Default ≈ 6%		0.00%		40.00	(0)	
Drainage/Water/Sewer	(3-10%)of (a+b)		19.00%	Carrie	\$4,104,089.60	(D)	
	Default = 6%		PS: PS: AN	a mune a		Clear France	
Signing and Striping	(1-5%) of (a+b+c+d)		1.00%	Carrier	\$451,449.86	(E)	
	Default = 5%		A dear		4101,410.00	(-)	
		19 // C.	ISTAC STOR	Section 2	10 101 750 10		
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e Default = 20%	}	7.00%	Carrie	\$3,191,750.48	(F)	
			No. of Lot	1.186			
Nobilization	(4 to 10%) of (a+b+c+d+	e+f)	7.00%	Carrie	\$3,415,173.02	(G)	
	Default = 7%		1100日30				
fotal of Construction items	(a+b+c+d+e+f+g)				\$52,203,358.95	10	
	(a+0+C+0+e+i+g)		「ない」の目的の		\$32,203,358.95	(H)	
Force Account - Utilities	(1 to 2%) of (h)		2.00%	Carries	\$1,044,067.18	(1)	
	Default = 2%		2.00%	C-BITHER	\$1,044,007.18		
Force Account - Misc.	(10 to 15%) of (h)		12.00%	Carrier	\$6,264,403.07	(J)	
VIVE / WARNIN - MIRTH	Default = 12%			STATES	40,204,403.07	(0)	
Subtotal of Construction Cost	(h+i+j)			SH REALESS	\$59,511,829.21	(K)	
			(IRGS 20)			ST.C.S.S.C.	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$10,117,010.97	(L)	
			Constant State				
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$8,926,774.38	(M)	
						51	
light of Way	Project Dependent		2.00%	2	\$1,044,067.18	(N)	
Jtilities	Project Dependent		N/A			(0)	
		ation and spinse of the	212. AROZA			(0)	
Tunnel (Twin Tunnels)	15000	0		1 01 147 H	\$0.00		
Tunnei (South Bore EJMT) interchanges	30000	O Transition of the second se			\$0.00		
Hiter Anter Mag			AND THE REAL	IS NO.		White Mark	
	ment Cost				579,599,681,73	(P)	

Diesel Bus in Guideway Floyd Hill Total Facilities Costs

Project Construction Items			
Item Description	Quantity P	Per Unit Cost	Cost
Square foot indoor space	.38 \$	105.00	\$65,015,409.38
Miscellaneous Equipment and furnishings	Variable	Variable	\$1,350,000.00 \$0.00
		Sub total	\$66,365,409.38
Mobile Maintenance Equipment			
Guideway double ended truck	2 \$	400,000.00	\$800,000.00
Miscellaneous trucks	5 \$	50,000.00	\$250,000.00
Toe Trucks	2 \$	100,000.00	\$200,000.00
Road Supervision	12 \$	30,000.00	\$360,000.00
		Sub total	\$1,610,000.00
		Total	\$67,975,409.38
Passenger Railcar Fleet	254 \$	325,000.00	\$82,550,000.00
Automatic Vehicle Location System	254 \$	10,000.00 Subtotal	\$2,540,000.00 \$85,090,000.00
Accumulation		Total	\$219,430,818.75

Assumptions

Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail).

Passenger rolling stock does not include paratransit vehicles. The inter urban system is not required to operate ADA complimentary service and the buses are ADA compatible with lifts. However, the feeder bus will be required to offer complimentary service. Those costs Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA Standards.

Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

Automatic Vehicle Location System shall include equipment, office space and dispatch costs.

\$250,000.00 \$200,000.00 \$0.00 \$1,000,000.00 \$44,375,500.00 \$800,000.00 \$360,000.00 \$45,985,500.00 43,375,500.00 17 Shop sized to hold 80% of the fleet indoors with a 100% for administrative offices, fueling, and heavy Δ 105 \$ 1000000 400,000.00 50,000.00 100,000.00 30,000.00 C Total Price 2 с С θ θ 12 2 413,100.00 18 Indoor space with the length of the Diesel bus, 45', width 8.5' and 14' lanes മ Quantity 3 Denver Facility: Heavy maintenance, cleaning, fueling, 6 Miscellaneous Equipment and furnishings 9 Mobile Maintenance Equipment 10 Guideway double ended truck 13 Road Supervision (mini vans) < 5 Square Foot Indoor Space 11 Miscellaneous trucks 4 and adminstration. 12 Toe Trucks 14 15 16 ω 2 ~

6

	Α	8	o	Q
-				
2				
m	3 Frisco Facility for Inspection, Overhaul, light and heavy maintenance			
4	and clearing with yard capacity for 40% of the fleet	Quantity	Per Unit Cost Cost	Cost
5	Indoor Square Foot	171,163.13	\$ 105.00	\$ 17,972,128.13
9	Miscellaneous Equipment and furnishings	-	\$ 250,000.00	\$ 250,000.00
~				•
8			sub total	\$ 18,222,128.13
6	9 Project Construction Items			
10	10 Item Description	Quantity	Per Unit Cost	Cost
				•
12				•
13				۰ چ
14			Total	\$ 18,222,128.13
15				
4	te An additional 150/ was added to the floor among			
의	All auditional 10% was aureu to the 1001 space			

3,667,781.25 100,000.00 3,767,781.25 3,767,781.25 ī Δ Cost မာ မ θ θ 105 100000 Per Unit Cost C Total Total Price 1.00 34,931.25 Quantity മ Quantity 17 An additional 15% was added to the floor space 7 Miscellaneous Equipment and furnishings 3 Glenwood Facility for light car maintenance and4 cleaning with yard capacity for 10% of the fleet **Project Construction Items** Item Description < 6 Indoor Square Foot 10 12 13 14 15 16 œ σ ഹ 2

Stations	Peak Ons	Peak Hr	Fare Demand	Round up	Minimum	Off site	Total	Location	by loc
Westminster	620	155	5	. 6	0		6	1	
6th & Laurel	477	119	4	4	0		4	1	
A-Basin	26	7	0	1	0		1	1	
Arapahoe pnR	384	96	3	4	0		4	1	
Arvada	226	56	2	2	Ő		2	1	
Denver Union Sta	600	150	5	5	õ	24		1	
DIA	663	166	6	6	Ő	4		1	
Jefferson Sta	825	206	7	7	õ	5		1	
Pena pnR	457	114	4	4	Ő	, i i i i i i i i i i i i i i i i i i i	4	1	
Silverthorne TC	662	166	6	6	ő	2		1	
Stapleton TC	482	120	4	5	ő	-	5	1	85
El Rancho	468	117	4	4	õ	2	-	2	6
US 6 / Gaming	257	64	2	3	0	2	3	2	0
Blackhawk	359	90	3	3	ő		3	3	
Central City	325	81	3	3	0		3		
Empire	281	70	2	3	0 0	1		3	13
Vineral Sta	582	146	5	5	0	· · · · · · · · · · · · · · · · · · ·	45	-	13
Idaho Springs	1000	250	8	9	0		э 9	4	
Johnson Park	96	230		9	0		-	4	
Keystone	286	72	2	1	-		1	4	
Winter Park	414	103	2 3	1	0		1	4	16
Avon	418	103	3	4	0		1	5	
Bell Tower	26	6	3 0	•	-		4	5	
CO 9 & French	6	1	0	1	0		1	5	
CO 9 & Watson	450	113	-	1	0		1	5	
Copper Circle	450 309	77	4	4	0		4	5	
Copper Entrance	500		3	3	0		3	5	
Frisco TC	2097	125 524	4	5	0	1		5	
Georgetown	2097		17	18	0	4		5	
oveland Ski		12	0	1	0	1	_	5	
	46	11	0	1	0	1	-	5	
	1200	300	10	10	0		10	5	56
/ail TC	866	216	7	6	0	1		6	7
Volcott	47	12	0	1	0		1	7	
otsero	40	10	0	1	0		1	7	
Eagle	67	17	1	1	0		1	7	
Eagle & 1-70	218	55	2	2	0		1	7	
Edwards	512	128	4	5	0		1	7	
GE East	149	37	1	2	0		1	7	
GE West	3	1	0	1	0		1	7	
Slenwood Springs	1	0	0	1	0		1	7	
Sypsum	77	19	1	1	0		1	7	
Gypsum & 1-70	3	1	0	1	0		1	7	
Vard Road	203	51	2	2	0		2	7	12

min

2

Assumptions

20% of riders have purchased tickects at Idaho Springs, A23Vail, Frisco, and Jefferson 10% of all riders have purchased tickets before Only one machine per station west of Vail. Copper Mountain was set from HRT analsysis

Fare Card Machines	Machines at Other
Station	Locations
DIA	4
DUSDenver Metra	24
Stapleton	2
Jefferson	ŧ
El Rancho	
US 6/Gaming	1
Idaho Spgs	1
Empire Jct	2
Georgetown	1
Loveland Ski	1
Silverthorne TC	1
Frisco TC	4
Copper Mtn	1
Vail TC	1
West of Vail	9
	58

BID ITEMS	COST PER UNIT	QUANTITY	COST		_
Structures	150.00	0	0.00		
Walls	90.00	484108	43,569,720.00		
Earthwork	20.00	203038	4,060,720.00		
Pavement	70.00	0	0.00		
Base Course	40.00	0	0.00		
Barrier	60.00	0	0.00		
Guideway Structure (LF)	3200.00	71000	227,200,000.00		
Tunnel (Twin Tunnels)	t5000	0	0.00		
Tunnel (South Bore EJMT)	30000	0	0.00		
interchanges Guided Busway Track	0 315	0	0.00		
Maintenance Facilities	Variable	<u>267168</u> 3	\$84,157,920.00 \$84,500,000.00		
Mobile Maintenance Vehicles	Variable	21	\$2,000,000.00		
Ramps for Busses	2000000	12	\$24,000,000.00		
Stations/Parking (Large)	1000000	3	\$30,000,000.00		
Stations/Parking (Medium)	6000000	1	\$6,000,000.00		
Station (Small)	3000000	9	\$27,000,000.00		
Fare Collection (Fare vending machines)	37000	188	\$6,956,000.00		
Passenger Rollingstock	900000	244	\$219,600,000.00		
Automatic Vehicle Location System	2928000	1	\$2,928,000.00		
tal			761,972,360.00		
			HE REAL STRAILS AND A STRAIL STRAIL		
				872 -	
	% Range		% Used	Cost	
minut Construction Name (and a summer)					
roject Construction Items (per segment)				\$537,444,360.00	
roject Construction Bid Items	Project Dependent		NA	\$224,528,000.00 \$761,972,360.00	
	i toleor Dehendetir			\$101,812,300.00	(#
Contingencies*	(15% - 30%) of (A)		30.00%	\$228,591,708.00	(E
			ALL STATES	+===============	(1
				100 M	
rs	(6-10%) of (A+B)	A DESCRIPTION OF A DESCRIPTION	0.00%	\$0.00	(0
	Default = 6%		What is a state of the second state		
)rainage/Utilities	12 408/ 1-((A + D)				
n amager Ountres	(3-10%)of (A+B) Default = 6%		10.00%	\$99,056,406.80	(C
	Derault - 0 %			5557	
igning and Striping	(1-5%) of (A+B+C+D)		1.00%	\$10,896,204.75	(E
	Default = 5%			\$10,030,204.15	"-
construction Signing & Traffic Control	5 10 25% of (A+B+C+D	+E)	7,00%	\$77,036,167.57	(F
	Defauit = 20%				
Abilization	(4 to 10%) of (A+B+C+	D+E+F)	7.00%	\$82,428,699.30	(G
	Defauit = 7%				
		-		201	
otal of Construction Bid Items	(A+B+C+D+E+F+G)			\$1,259,981,546.41	(1-
	-			• 11200100 110 10:11	1.1.1
orce Account - Utilities	(1 to 2%) of (H)		2.00%	\$25,199,630.93	(1
	Default = 2%				
orce Account - Misc.	(10 to 15%) of (H)		12.00%	\$151,197,785.57	()
	Default = 12%				
ubtotal of Construction Cost	(H+I+J)			\$1 436 378 000 04	
	(initia)			\$1,436,378,962.91	(H
otal Construction Engineering	17% of (K)		17.00%	\$244,184,423.70	(1
			and the second se	WETT 101 120.10	(1
otal Preliminary Engineering**	15% of (K)		15.00%	\$215,456,844.44	(N
		A CONTRACTOR OF THE OWNER OF THE			180
					35
ght of Way	Project Dependent		2,00%	\$25,199,630.93	(1
					- tu
tilities	Project Dependent		N/A	\$0.00	(0
					Sir
and the second	COST	QUANTITY		AVER .	
Tunnel (Twin Tunnels) (LF)	15000.00	0.	00	0.00	
Tunnel (South Bore EJMT) (LF)	30000.00				
interchanges (EACH) Electrification	0.00	Vadeble	\$67,650,000.00	I I	
LICCUIIICAUUT	67,650,000.00	Variable	00.000,066	ALCON .	
A STATUTE ALL AND A DESCRIPTION OF A DES	ETER MANAGEMENT AND ADDRESS OF A DESCRIPTION	AMERICAN		\$1,921,219,861.97	(F
tal Project Cost					
tal Project Cost	and the second second second	- 中心学习 这个个 的 书		COST - COST - COST	122

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Estimate Worksheet				相同的		5 14	
The second s	% Range		% Used			6.64	
Stated Assumptions							
Stated Assumptions	Concerned and the local	an a					
Project Construction Items				114			2
Item Description Structures	Quantity	Per Unit Cost 150			Cost \$0.00		8
Walls	393359	90		1016	\$35,402,310.00		8
Earthwork	174826	20	a criteria	1-2212	\$3,496,520.00		
Pavement Rana Cauma	0				\$0.00		
Base Course Barrier	0				\$0.00	1913	1
Guideway Structure (LF)	47000				\$150,400,000.00	CT ST CAN	8
Tunnel (Twin Tunnels)	0	15000		在民国	\$0.00		1
Tunnel (South Bore EJMT)	0			And Adams	\$0.00		
Interchanges Gulded Busway Track	69960	0			\$0.00	而以	
Maintenance Facilities	1	\$55,500,000.00			\$55,500,000.00		
Ramps for Busses	2	2000000			\$4,000,000.00		d
Stations/Parking (Large)	1	1000000			\$10,000,000.00		
Stations/Parking (Medium) Station (Small)	0	6000000 3000000			\$0.00		
Fare Collection	65			家民国	\$3,145,000.00		
				-10-11			
Total accounted construction items					\$286,981,230.00	(A)	Carried to Sheet Or
Contingencies	(15% - 30%) of (A)		30 00%	Carrie	\$86,094,369.00	(B)	
Established as a percentage	1			E F		104	10 10 10
TS	(6-10%) of (a+b) Default = 6%		0.00%	Carrie	\$0.00	(C)	
	Default = 6%			N. Contraction			<u>.</u>
Drainage/Water/Sewer	(3-10%)of (a+b) Default = 6%		10.00%	Cante	\$37,307,559.90	(D)	
Signing and Striping	(1-5%) of (a+b+c+d) Default = 5%		3.00%	Carrie	\$12,311,494.77	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d	+a)	15.00%	Certie	\$63,404,198.05	(F)	
	Default = 20%		10.0016	19.49		01.61	
Abbilization	(4 to 10%) of (a+b+c+	d+e+f)	7.00%	Carrie	\$34,026,919.62	(G)	
	Default = 7%						
otal of Construction Items	(a+b+c+d+e+f+g)				\$520,125,771.34	(H)	
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$10,402,515.43	(1)	
Force Account - Misc.	(10 to 15%) of (h)		12.00%	Carrie	\$62,415,092.56	(J)	
	Default = 12%			a carlle			
iubtotal of Construction Cost	(h+i+j)		1.0	S.C.E	\$592,943,379.32	(14)	
otal Construction Engineering	17% of (k)		17.00%	Салте	\$100,800,374.49	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$88,941,506.90	(M)	
Occurrentinitary cirginiteering	15% 01 (k)		18.00%	Carno	\$66,941,906,90	(114)	
light of Way	Project Dependent		2.00%	E Z	\$10,402,515.43	(N)	
Wittes	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels) (LF) Tunnel (South Borg EJMT) (LF)	1 15000 30000	0 Q			\$0.00 \$0.00	1948.	
Interchanges"(EACH) Electrification	1 Veriable	0	GUITAN	N-MARTIN	\$0.00 \$11,000,000.00		8
Total Segment Coe	A State Containing	and the second second			\$795,087,776.14	(20)	
			STREET, LOUPE		3/83,067,778,14	(P)	10

Estimate Worksheet			and the second			2025	
	% Range		% Used				5
Stated Assumptions							
				ALC: N			
Project Construction Items			ALL DA				200 C
Item Description Structures	Quantity	Per Unit Cost 150		ER-	Cost \$0.00		
Walls	0	90	PK STUR		\$0.00		
Earthwork	0	20	生动适合		\$0.00		
Pavement Base Course	0	70			\$0.00		
Barrier	0	60	NEL		\$0.00		
Guideway Structure (LF)	0	3200			\$0.00		
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	0	15000	44.5%		\$0.00		11
Interchanges	0	3000	ない。こ		\$0.00		
Guided Busway Track	75240	315			\$23,700,600.00		
Maintenance Facilities Ramps for Busses	0	\$0.00 2000000		HE S	\$0.00		3
Stations/Parking (Large)		1000000			\$4,000,000.00		7
Stations/Parking (Medlum)	0	6000000		10	\$0.00		No. Contraction of the second
Station (Small) Fare Collection		3000000			\$3,000,000.00		
Fare Collection	6	37000	in le t		\$222,000.00		
Total accounted construction items	A SUMPLEMENT		San Kalik		810 000 000 00		
		and the second second			\$40,922,600.00	(A)	Carried to Sheet O
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$12,276,780.00	(B)	
Establised as a percentage				THE .	*******	(5)	1.00
8	(6-10%) of (a+b)		0.00%	Carrie	\$0.00	(C)	
	Default = 6%						-
ainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$5,319,938.00	(D)	
	Default = 6%			現代の			
aning and Striping	(1-5%) of (a+b+c+d) Default = 5%		3,00%	Carrie	\$1,755,579.54	(E)	
nstruction Signing & Traffic Control	5 to 25% of (a+b+c+d+e Default = 20%	9)	15.00%	Carrie	\$9,041,234.63	(F)	
bilization	(4 to 10%) of (a+b+c+d-		*	Part -	AL 050 (00 05		
	Default = 7%		7.00%	Carrie	\$4,852,129.25	(G)	
tal of Construction Items	(a+b+c+d+e+f+g)				\$74,168,261.42	(H)	1
rce Account - Utilities	(4 14 000) - ((b))			EX EX			
	(1 to 2%) of (h) Default = 2%		2.00%	Carrier	\$1,483,365.23	(I)	
rce Account - Misc.	(10 to 15%) of (h)		12:00%	Carrier	\$8,900,191.37	(J)	1
	Default = 12%		No.	fal fil			A
biotal of Construction Cost	(h+l+j)				\$84,551,818.02	(K)	
tal Construction Engineering	17% of (k)		17.00%	Carrie	\$14,373,809.06	(L)	
			S ANTE	211			
tal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$12,682,772.70	(M)	0
ht of Way	Project Dependent		2.00%		R1 403 305 00	(81)	
			8781		\$1,483,365.23	(N)	
lities	Project Dependent	Contraction of the second second	N/A			(0)	
Tunnel (Twin Tunneia) (LF) Tunnel (South Bore EJMT) (LF) Interchanges (EACH)	15000 30000 1	0 0 0		4	\$0.00 \$0.00 \$0.00		
Electrification	Variable	11,000,000.00		36	\$11,000,000.00		
Total 8	Self in sec. 1 () as set to 127 (), a subscript of All a subscript ()		(开始中代)	Contraction of the	\$113,091,765.02	(P)	927

Estimate Worksheet							
	% Range		% Used			THE REAL PROPERTY	
Stated Assumptions			21	Sam		1223	
Project Construction Items				5		Kinese .	
Item Description Structures	Quantity	Per Unit Cost 150			Cost \$0.00		
Walls	0	90			\$0.00	47世代世纪(
Earthwork Pavement	0				\$0.00	C. Statistics	
Base Course	0				\$0.00 \$0.00	10.400	5
Barrier	0	60		的名词语	\$0.00	2.2800113	
Guideway Structure (LF) Tunnel (Twin Tunnels)	0				\$0.00 \$0.00		2
Tunnel (South Bore EJMT)	0				\$0.00	107	
Interchanges	0	0			\$0.00	2.53世纪19	
Guided Busway Track Maintenance Facilities	87120	315 \$0.00		Creek.	\$27,442,800.00 \$0.00	ASAL AR	
Ramps for Busses	2	2000000	SCOURL!		\$4,000,000.00	IINODAL ST	
Stations/Parking (Large) Stations/Parking (Medium)	0	10000000 6000000			\$0.00 \$6,000,000.00	320257	
Station (Small)	1				\$3,000,000.00	() 为17/3	
Fare Collection	13	37000	and and a state		\$481,000.00	HTTO AVE	
Total accounted construction items					\$40,923,800.00	(8)	Carried to Sheet On
					410,020,000.00		
Contingencies	(15% - 30%) of (A)		30.00%	Carrier	\$12,277,140.00	(B)	
Establised as a percentage			00.007		\$12,217,140.00	(6)	
6	(6-10%) of (a+b) Default = 6%		0.00%	Сатты	\$0.00	(C)	
ainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrier	\$5,320,094.00	(D)	
	Default = 6%		10.00 4		43,320,054.00	(0)	
gning and Striping	(1-5%) of (a+b+c+d) Default = 5%		3.00%	Carrie	\$1,755,631.02	(E)	
			V and part				
Instruction Signing & Traffic Control	5 to 25% of (a+b+c+d+ Default = 20%	e)	15.00%	Carrie	\$9,041,499.75	(F)	
bilization	(4 to 10%) of (a+b+c+d	+e+f)	7.00%	Саттіех	\$4,852,271.53	(G)	
	Default = 7%		12 102				
tal of Construction Items	(a+b+c+d+e+f+g)				\$74,170,438.31	(H)	
rce Account - Utilities	(1 to 2%) of (h)		2.00%	Carrier	\$1,483,408.73	(I)	
	Default = 2%		ALCONTON 1		\$1,403,400.73	w.	
rce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrie	\$8,900,452.38	(J)	
btotal of Construction Cost	(h+i+j)		-22		\$84,554,297.39	(K)	
tal Construction Engineering	17% of (k)		17.00%	Carrie	\$14,374,230.56	(L)	
tel Benferlanny Englanding							
tal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$12,683,144.61	(M)	
ht of Way	Project Dependent		2.00%		\$1,483,408.73	(N)	
lities	Project Dependent		NA		*1,100,100,10	1 and the	
Tunnel (Twin Tunnels)	15000		我的 的问题			(0)	
Tunnel (South Bore EJMT)	30000	0 0 0			\$0.00 \$0.00		
Interchanges	Madatta	0		1 2 3 7 1	\$0.00	the life	
Electrification	Variable gment Cost	13,000,000.00	State of the	16 - CO	\$13,000,000.00	(P)	

Estimate Worksheet						1100	
an a	% Range		% Used	C. Californi		A REALESS	
				D. NY		建物合金	
Stated Assumptions			Miners of the			1.1.5 A.	
Project Construction Items				and an and a second		2 min sel	
Item Description	Quantity	Per Unit Cost			Cost	85.06 JULY	
Structures	0	150		Store and	\$0.00	結合に出い	
Walls Earthwork	0	90			\$0.00 \$0.00	Weak added	
Pavement		70			\$0.00	N GRE	
Base Course	0	40		and the second second	\$0.00	DALE ES	
Barrier	0	60		語見得到	\$0.00	S. Pertition	
Guideway Structure (LF)	0	3200		12	\$0.00	和同時也	
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	0	15000 30000		f the second	\$0.00		
Interchanges		0			\$0.00 \$0.00	PROPERTY OF	
Guided Busway Track	3168	315		A MARCH	\$997,920.00	10251356	
Maintenance Facilities	0	\$0,00	自然而且		\$0.00	汉高新的代	
Ramps for Busses	2	200000			\$4,000,000.00	制作的的改革	
Stations/Parking (Large)	0	1000000			\$0.00	NELES REAL	
Stations/Parking (Medium) Station (Small)	0	6000000		CO PROCESS	\$0.00 \$6,000,000.00	Free and a d	
Fare Collection	16	3000000 37000			\$592,000.00	CREESING	
T die Gewoodon	10	01000			4002,000.00	1221/2012/201	
Total accounted construciton items			1 2 4 1 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		\$11,589,920.00	(8)	Carried to Sheet Or
						STOLOTES IL STOLES	
Contingencies	(15% - 30%) of (A)		30.00%	Carrie	\$3,476,976.00	(B)	
Establised as a percentage				10000			
ΓS	(6-10%) of (a+b) Default = 6%		0.00%	Carrier	\$0.00	(C)	
Prainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carries	\$1,506,689.60	(D)	
	Default = 6%						
Signing and Striping	(1-5%) of (a+b+c+d) Default = 5%		3.00%	Carrie	\$497,207.57	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e) Default = 20%		15.00%	Carrie	\$2,560,618.98	(F)	
Aobilization	(4 to 10%) of (a+b+c+d+c Default = 7%	i+ŋ	7.00%	Carrie	\$1,374,198.85	(G)	
fotal of Construction Items	(a+b+c+d+a+f+g)		(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	CONCE CONCE	P01 005 040 00		
oral of construction nems	(arbreturari+g)				\$21,005,610.99	(H)	
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$420,112.22	(1)	
orce Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Carrier	\$2,520,673.32	(J)	
ubtotal of Construction Cost	(h+i+j)				\$23,946,396.53	(K)	
otal Construction Engineering	17% of (k)		17.00%	Салтіе	\$4,070,887.41	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrie	\$3,591,959.48	(M)	
ight of Way	Project Dependent		2,00%		\$420,112.22	(N)	
tillties	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels) Tunnel (South Bore EJMT)	15000	0	用用方法	6 2763 - 7 2031 -	\$0.00 \$0.00		
Electrification	Variable	0 650,000.00		CP (78,557) (2)	\$0.00	1967 (196-3)	
				S LANG		101	
Total Se	gment Cost	LARKE DE MER DOLLARS HOUSE	TYNER BALL	timber All	\$32,029,355.64	(P)	

Estimate Worksheet			diniti-				
	% Range		% Used			1.4.3140.00.0	
				EP INGEN		DAY STA	
Stated Assumptions						122	
Project Construction Items			Walls and			· 74 1974	
Item Description	Quantity	Per Unit Cost		-	Cost	(1) (1)	
Structures Walls	0	150		15 1000098 201 405 1901	\$0.00 \$0.00	CALCS 12	
Earthwork	0	30			\$0.00	Section Division	
Pavement	0	70			\$0.00	A STREET	
Base Course	0	40			\$0.00	20人1年后	
Barrier		60			\$0.00	「「「「」	
Guideway Structure (LF) Tunnel (Twin Tunnels)	0	3200		ALC: NAME OF OCTOBER	\$0.00 \$0.00	A DECLASSING	
Tunnel (South Bore EJMT)	0	30000			\$0.00	Stanica.m	
Interchanges	0	(ROURS	\$0.00	MALL CONTR	
Guided Busway Track	12144	315			\$3,825,360.00	20.02	
Maintenace Falcilities Ramps for Busses	1	22,500,000.00	A.Betafordaria	Distantial	\$22,500,000.00 \$4,000,000.00	SILLAR VILLAR	
Stations/Parking (Large)	0	1000000			\$4,000,000.00	Searcestre	
Stations/Parking (Medium)	0	600000		18 5192	\$0.00	NP 1945 - 14	
Station (Small)	2	300000	自己没有能够	が、日本語	\$6,000,000.00	(信息為)司	
Fare Collection	56	37000		A	\$2,072,000.00		
Total accounted construction items					\$38,397,360.00	(8)	Carried to Sheet Or
					000,001,000.00	(0)	
Contingencies	(15% - 30%) of (A)		30.00%	Carried	\$11,519,208.00	(8)	
Establised as a percentage					411,513,200.00	(0)	
TS	(6-10%) of (a+b) Default = 6%		0.00%	Carrier	\$0.00	(C)	
Drainage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$4,991,656.80	(D)	
	Default = 6%						
Signing and Striping	(1-5%) of (a+b+c+d) Default = 5%		3.00%	Carrie	\$1,647,246.74	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e) Default = 20%	1	15.00%	Сатте	\$8,483,320.73	(F)	
Aobilization	(4 to 10%) of (a+b+c+d+	e+f)	7.00%	Carrie	\$4,552,715.48	(G)	
	Default = 7%						
Fotal of Construction Items	(a+b+c+d+e+f+g)				\$69,591,507.73	(H)	
Force Account - Utilities	(1 to 2%) of (h)		2.00%	Carrie	\$1,391,830.15	(1)	
	Default = 2%		Carlor (Carlor) Relation				
Force Account - Misc.	(10 to 15%) of (h) Default = 12%		12.00%	Сатте	\$8,350,980.93	(J)	
Subtotal of Construction Cost	(h+i+j)				\$79,334,318.82	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrie	\$13,486,834.20	(L)	
Total Preliminary Engineering	15% of (k)		15.00%	Carrie	\$11,900,147.82	(M)	
Right of Way	Project Dependent		2.00%		\$1,391,830.15	(N)	
Milities	Project Dependent		N/A			(0)	
Tunnel (Twin Tunnels)	t5000	Channel Hope 1.5		a catego	\$0.00	Did .	
Tunnel (South Bore EJMT)	30000	0		E EASA	\$0.00		
Interchanges Electrification	Variable 1	2,000,000.00		计可能存在	\$0,00 \$2,000,000.00	1945	
	A GIVENTE	2,000,000.00	STATE OF STREET	A REALING	\$2,000,000.00	in the second	

Estimate Worksheet			1 States			1 (m)-	a
	% Range		% Used			20-15-14	2 2
			-			SA SANCES	
Stated Assumptions				14		ZOWE-MODE	-
Project Construction Items			A had to day at our of some				
Item Description	Quantity	Per Unit Cost		ROBS	Cost	NUR	9
Structures Walls	0 90749	150			\$0.00	同時間に同じ	
Earthwork	28210	90			\$8,187,410.00 \$564,200.00	ALL ROAD	8
Pavement	0	70			\$0.00	APPROX NO	
Base Course	0	40			\$0.00		
Barrier Guideway Structure (LF)	0 24000	60 3200			\$0.00 \$78,800,000.00	1. Parta V.	2h
Tunnel (Twin Tunnels)	24000	15000			\$0.00	STREET CON	
Tunnel (South Bore EJMT)	0	30000		S STAR	\$0.00	NOR BUCK	
Interchanges	0	0			\$0.00	的时候, 在13月	
Guided Busway Track Ramps for Busses	2	315 2000000	2 19 10	29 (2015) 28 12888	\$6,153,840.00 \$4,000,000.00	616-7	
Maintenance Facilities		\$6,500,000.00		and an inter	\$6,500,000.00	ST THE	
Stations/Parking (Large)	1	10,000,000.00		劇開始的	\$10,000,000.00		
Stations/Parking (Medium)	0	600000			\$0.00	1999年(22	5
Station (Small) Fare Collection	2	3000000 37000		ella pelleccia Logi chilosectori	\$6,000,000.00 \$444,000.00	E450516920	
1 4 9 9000001	12	37000		RINGS	\$444,000.00	-	
Total approximated approximation Many			11-12-5	12 23 26		1. 199	2
Total accounted construction items					\$118,629,450.00	(a)	Carried to Sheet Or
Contingencies	(15% - 30%) of (A)		30.00%	Cante	\$35,588,835.00	(8)	
Establised as a percentage			SUNCE		\$33,300,033.00	(8)	
'S	(6-10%) of (a+b) Default = 6%		0.00%	Carrier	\$0.00	(C)	
ralnage/Water/Sewer	(3-10%)of (a+b)		10.00%	Carrie	\$15,421,828.50	(D)	
	Default = 8%						
Signing and Striping	(1-5%) of (a+b+c+d) Default = 5%		3.00%	Carrie	\$5,089,203.41	(E)	
Construction Signing & Traffic Control	5 to 25% of (a+b+c+d+e) Default = 20%		15.00%	Carrie	\$26,209,397.54	(F)	
fobilization	(4 to 10%) of (a+b+c+d+e	+1)	7.00%	Carrie	\$14,065,710.01	(G)	
	Default = 7%						
otal of Construction items	(a+b+c+d+a+f+g)				\$215,004,424.45	(H)	
orce Account - Utilities	(1 to 2%) of (h) Default = 2%		2.00%	Carrie	\$4,300,088.49	(1)	
orce Account - Misc.	(10 to 15%) of (h)			a guile	AGE 200 500 00		
	Default = 12%		12.00%	Carrie	\$25,800,530.93	(J)	
ubtotal of Construction Cost	(h+i+j)		新知道之前。	建設設設	\$245,105,043.87	(K)	
otal Construction Engineering	17% of (k)		17.00%	Carrier	\$41,667,857.48	(L)	
otal Preliminary Engineering	15% of (k)		15.00%	Carrier	\$36,785,756.58	(M)	
					+00,100,100,00	(141)	
ight of Way	Project Dependent		2.00%		\$4,300,088.49	(N)	
tilities	Project Dependent		N/A		}	(0)	
Tunnel (Twin Tunnels)	15000	0	NET OFFICE	A CLARKE	\$0.00	1 AND	
Tunnel (South Bore EJMT)	30000	0	Sec La		\$0.00	Carlos Carlos	
Electrification	Variable	0 3000000	USCAL WAS	C PILODES	\$0.00	area and a second	
Lieurincauon	Vanade	30000000	CONCE 1		\$30,000,000.00	A AND A	
	pment Cost	and the second se	and the second se	And in case of the local division of the loc	\$327,838,748.40	(P)	

313,103 238,500 104,368 6,957,840 46,341,504 254,400 1,908,000 2,385,000 2,385,000 4,842,35 TOTAL COST 17,723 5,908 135,000 13,500 108,000 135,000 ,623,104 14,400 274,095 393,840 **ABOR COST** 98,460 4.568.256 2,250,000 225,000 43,718,400 240,000 1,800,000 2,250,000 295,380 6,564,000 TOT. UNIT COSI **\$\$** Ю Э θ ŝ 15 50,000 5,000 10 10,000 40,000 45 50,000 18,480 UNIT COST Ю θ θ ⇔ Э 2188 6564 5 247.2 6564 45 24 45 45 437184 UNITS REQ. LINIT MILE POWER DISTRIBUTION SYSTEM MAIN LINE ITEM DESCRIPTION 1000 KVA SUBSTATION W/RECT AUTOMATIC TIE SWITCH CIRCUIT BRK. AUTO A.C. CIRCUIT BRK. AUTO D.C. **12 KV INSULATORS 12 KV SPACERS** POWER POLES 12 KV WIRE SCADA

\$ 1,540,553 Cost/Mile

78,876,079

78,876,079

Cost Rounded to

13, 146, 013

65,730,066

SUBTOTAL 20% CONT

> MILES FEET

13.25 System Voltage = 750v d.c. 69960 System Length = 64.48

A.) Base Consist = One Bus

B.) Base Energy required in KWH = 328 KWH

C.) Energy required in KVA = B.x1.38 = 453 KVA

D.) Number of consists required = 84/Hour

E.) Energy required one direction = CxD = 38,052 KVA

F.) Energy required for both directions = 2xE = N/A G.) Substations required = System Length x 1 Substation per 2 Miles = 32

H.) Substation KVA = F/G = 865 KVA

ITEM DESCRIPTION	UNIT	UNITS REQ. U	UNIT COST	TOT. UNIT COST	LABOR COST	2	TOTAL COST
12 KV WIRE	MILE	39.75 \$	18,480	\$ 734,580	\$ 44,075	\$	778,655
12 KV INSULATORS	EA.	1050 \$	45	\$ 47,250	\$ 2.835	\$	50,085
12 KV SPACERS	EA.	1050 \$	15	\$ 15,750	\$ 945	\$	16,695
1000 KVA SUBSTATION W/RECT	EA.	2 \$	50,000	\$ 350,000	\$ 21,000	\$	371,000
AUTOMATIC TIE SWITCH	EA.	2 \$	5,000	\$ 35,000	\$ 2,100	\$	37,100
POWER POLES	ĒĄ	350 \$	3,000	\$ 1,050,000	\$ 63,000	\$	1,113,000
POWER DISTRIBUTION SYSTEM MAIN LINE	FT.	\$ 09669	100	\$ 6,996,000	\$ 419,760	\$	7,415,760
SCADA	EA.	4	10,000	\$ 40,000	\$ 2,400	\$	42,400
CIRCUIT BRK. AUTO A.C.	EA.	2 \$	40,000	\$ 280,000	\$ 16,800	\$	296,800
CIRCUIT BRK. AUTO D.C.	EA.	\$ 2	50,000	\$ 350,000	\$ 21,000	\$	371,000
				ج	ج	ŝ	ı
				ج	ج	θ	
				ج	' ج	ŝ	
					Total	θ	10,492,495

MILES FEET

13.25 69960

ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	TOT. UNIT COST	ST	LABOR COS	(COST	.0T	TOTAL COS	Ē
12 KV WIRE	MILE	48.3	\$ 18,480	\$ 892,584	584	\$	53,555	\$	946,139	139
12 KV INSULATORS	EA.	1308	\$ 45	\$ 58,	58,860	\$	3,532	Ф	62	62,392
12 KV SPACERS	EA.	1308	\$ 15	\$ 19,62(620	¢	1,177	ŝ	20,	797
1000 KVA SUBSTATION W/RECT	EA.	6	\$ 50,000	\$ 450,000	8	\$	27,000	\$	477,000	000
AUTOMATIC TIE SWITCH	EA.	6	\$ 5,000	\$ 45,000	8	\$	2,700	\$	47,	700
POWER POLES	EA.	436	ŝ	\$ 1,308,	8	\$	78,480	ŝ	1,386,	480
POWER DISTRIBUTION SYSTEM MAIN LINE	Ŀ.	87120	\$ 100	\$ 8,712,000	00	\$	522,720	\$	9,234,720	720
SCADA	EA.	4	\$ 10,000	\$ 40,000	00	\$	2,400	\$	42,	400
CIRCUIT BRK. AUTO A.C.	EA.	o	\$ 40,000	\$ 360,000	00	¢	21,600	\$	381,	600
CIRCUIT BRK. AUTO D.C.	ËĄ.	6	\$ 50,000	\$ 450,1	00	\$	27,000	⇔	477,000	000
				\$		ŝ	•	69		1
				\$		\$	•	\$		
				\$		ŝ	•	φ		
						Total		÷	13,076,228	228

16.1 87120

MILES Feet

ITEM DESCRIPTION	UNIT	UNITS REQ. UNIT COS	N	T COST	TOT. UNIT COST	P	LABOR COST	TOT/	TOTAL COST
12 KV WIRE	MILE	1.8	φ	18,480	\$ 33,264	φ	1,996	Ś	35,260
12 KV INSULATORS	ĒĀ	48	φ	45	\$ 2,160	θ	130	ŝ	2,290
12 KV SPACERS	ËĄ.	48	ŝ	15	\$ 720	ŝ	43	ŝ	763
1000 KVA SUBSTATION W/RECT	EA.	-	φ	50,000	\$ 50,000	÷	3,000	φ	53,000
AUTOMATIC TIE SWITCH	EA.	-	θ	5,000	\$ 5,000	θ	300	\$	5,300
POWER POLES	Ë.	16	φ	3,000	\$ 48,000	θ	2,880	θ	50,880
POWER DISTRIBUTION SYSTEM MAIN LINE	Ŀ.	3168	φ	100	\$ 316,800	ŝ	19,008	\$	335,808
SCADA	Ē.	4	θ	10,000	\$ 40,000	φ	2,400	÷	42,400
CIRCUIT BRK. AUTO A.C.	Ĕ	-	θ	40,000	\$ 40,000	ŝ	2,400	φ	42,400
CIRCUIT BRK. AUTO D.C.	Ë.	-	θ	50,000	\$ 50,000	φ	3,000	÷	53,000
					، ج	ω	'	φ	2
					۰ د	θ	•	\$	ı
					' ډ	φ	•	ф	,
						Total		φ	621,101

0.6 3168

ITEM DESCRIPTION	UNIT	4 1	UNIT COST		TOT. UNIT COST	P	LABOR COST	Ĕ	TOTAL COST
	MILE	6.9	18,480	€ 0	127,512	φ	7,651	φ	135,163
≤		183	5 45	\$	8,235	φ	494	φ	8,729
≤		183	\$ 15	\$	2,745	\$	165	φ	2,910
≤.		2	\$ 50,000	\$	100,000	ŝ	6,000	θ	106,000
≤		2	\$ 5,000	\$	10,000	\$	009	θ	10,600
≤		61.9	\$ 3,000	\$	183,000	\$	10,980	⇔	193,980
Ŀ.		12144 \$	5 100	ഗ	1,214,400	ŝ	72,864	ŝ	1,287,264
Ä		4	10,000	\$	40,000	φ	2,400	ŝ	42,400
Ŕ		2	\$ 40,000	ده	80,000	ŝ	4,800	φ	84,800
Ż		2	5 0,000	↔ -	100,000	φ	6,000	φ	106,000
				θ	ı	φ	1	φ	•
				θ		ŝ	ı	φ	ı
				ŝ		ŝ	ı	φ	·
						Total		⇔	1,977,846

MILES FEET

2.3 12144

ITEM DESCRIPTION	UNIT	UNITS REQ.	UNIT COST	P	TOT. UNIT COST	۲	LABOR COST		TOTAL COST
12 KV WIRE	MILE	110.7	\$ 18,480	κ	2.045.736	မာ	122.744	ы	2 168 480
12 KV INSULATORS	Ŗ	2925	\$ 45	\$	131,625	ŝ	7.898	69	139.523
12 KV SPACERS	ĒĀ	2925	\$ 15	φ	43,875	Ś	2,633	ŝ	46.508
1000 KVA SUBSTATION W/RECT	Ē.	19	\$ 50,000	θ	950,000	θ	57,000	ŝ	1,007,000
AUTOMATIC TIE SWITCH	ĒĀ	19	\$ 5,000	φ	95,000	φ	5,700	ŝ	100,700
POWER POLES	ĒÀ	975	\$ 3,000	θ	2,925,000	φ	175,500	ω	3.100.500
POWER DISTRIBUTION SYSTEM MAIN LINE	Ŀ.	194832	\$ 100	θ	19,483,200	φ	1,168,992	ŝ	20.652.192
SCADA	ĒÀ	4	\$ 10,000	θ	40,000	ອ	2,400	ŝ	42.400
CIRCUIT BRK. AUTO A.C.	EA.	19	\$ 40,000	φ	760,000	\$	45,600	6	805.600
CIRCUIT BRK. AUTO D.C.	EA.	19	\$ 50,000	φ	950,000	θ	57,000	\$	1,007,000
				φ	,	ω		ŝ	. '
				φ	r	φ	•	ω	
				θ	•	θ		θ	
		Cost/Mile	\$ 1,540,553			Ö	Cost Rounded to	ŝ	29,069,902

MILES FEET

36.9 194832

36 Q

Dual Mode Bus Total Facilities Costs

Project Construction items Item Description	Quantity	Per Unit Cost	Cost
Square foot indoor space	788,535.00 \$	105.00	\$82,796,175.00
Miscellaneous Equipment and furnishings	Variable	Variable	\$1,350,000.00 \$0.00
		Sub total	\$84,146,175.00
Mobile Maintenance Equipment			
Guideway double ended truck	2\$	400,000.00	\$800,000.00
Miscellaneous trucks	5\$	50,000.00	\$250,000.00
Toe Trucks	2 \$	100,000.00	\$200,000.00
Road Supervision	12 \$	30,000.00	\$360,000.00
		Sub total	\$1,610,000.00
		Total	\$85,756,175.00
Passenger Railcar Fleet	244.00 \$	900,000,000	\$219,600,000.00
Automatic Vehicle Location System	244 \$	10,000.00	\$2,440,000.00
		Subtotal	\$222,040,000.00
A		Total	\$391,942,350.00

Assumptions

Track length at yards was calculated by taking the aggregate length of the cars required to be able to be stored. 30% was added to the total for non-storage track (only 15% at Vail).

Passenger rolling stock does not include paratransit vehicles. The inter urban system is not required to operate ADA complimentary service and the buses are ADA compatible with lifts. However, the feeder bus will be required to offer complimentary service. Those costs Size of buildings assumed trains will require 35ft width (includes the width of the train and 20 ft.between tracks, per AREMA Standards.

Square foot indoor space represents the sum of three yards: Vail, Frisco, and Denver.

Automatic Vehicle Location System shall include equipment, office space and dispatch costs.

1 2 1 2 2 Benver Facility: Heavy maintenance, cleaning, fueling, Quantity Price 105 \$54,432,000 \$1,000,000 \$1		ф	U	۵
2 3 Denver Facility: Heavy maintenance, clean 4 and administration. 5 Square Foot Indoor Space 6 Miscellaneous Equipment and furnisl 7 Mobile Maintenance Equipment (fractionance) 9 Mobile Maintenance Equipment (fractionance) 10 Guideway double ended fruck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 It 15 Shop sized to hold 80% of the fleet in				
 3 Denver Facility: Heavy maintenance, clean 4 and adminstration. 5 Square Foot Indoor Space 6 Miscellaneous Equipment and furnisl 7 8 Mobile Maintenance Equipment 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 Shop sized to hold 80% of the fleet in 16 				
 4 and adminstration. 5 Square Foot Indoor Space 6 Miscellaneous Equipment and furnisl 7 8 Mobile Maintenance Equipment 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 16 17 Shop sized to hold 80% of the fleet in 	ice, cleaning, fueling,	245X		
 5 Square Foot Indoor Space 6 Miscellaneous Equipment and furnisl 7 8 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 16 16 17 18 19 10 10 11 12 14 15 15 16 16 17 16 16 17 16 16 17 16 17 16 16 17 16 16 17 16 17 16 17 16 17 16 17 16 17 18 19 19 10 10 11 11 12 14 15 15 16 17 18 19 19 10 10 10 11 12 13 14 14 15 15 16 17 18 19 19 10 10 11 12 14 15 15 16 17 18 19 19 10 10 10 10 10 10 11 12 13 14 14 15 15 16 17 18 19 19 10 10 11 11 12 13 14 14 15 16 17 18 19 19 10 10 11 12 14 15 16 16 17 18<		Quantity	Price	
 Miscellaneous Equipment and furnis Mobile Maintenance Equipment Mobile Maintenance Equipment Guideway double ended truck Guideway double ended truck Miscellaneous trucks Toe Trucks Road Supervision (mini vans) Road Supervision (mini vans) Shop sized to hold 80% of the fleet in 		518,400.00	105	\$ 54,432,000.00
7 8 8 8 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 15 Shop sized to hold 80% of the fleet in the start of the fleet in the start of the fleet in the start of the s	id furnishings	-	1000000	\$1,000,000.00
8 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 15 Shop sized to hold 80% of the fleet in the flee			2	\$0.00
 9 Mobile Maintenance Equipment 10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 16 16 17 Shop sized to hold 80% of the fleet in 				\$55,432,000.00
10 Guideway double ended truck 11 Miscellaneous trucks 12 Toe Trucks 13 Road Supervision (mini vans) 14 14 15 Shop sized to hold 80% of the fleet in the sized to hold 80% of the sized to hold 80% of the sized to hold 80% of the sized to hold 80%	ment			
 Miscellaneous trucks Toe Trucks Road Supervision (mini vans) Road Supervision (mini vans) Shop sized to hold 80% of the fleet in the sized to hold 80% of t	¥	5	2 \$ 400,000.00	\$800,000.00
 12 Toe Trucks 13 Road Supervision (mini vans) 14 15 15 16 17 Shop sized to hold 80% of the fleet in the sized to hold 80% of the si		5	\$ 50,000.00	\$250,000.00
13 Road Supervision (mini vans) 14 14 15 15 16 16 16 16 17 Shop sized to hold 80% of the fleet in the bleet		2	\$ 100,000.00	\$200,000.00
14 15 16 17 Shop sized to hold 80% of the fleet ir	(12	\$ 30,000.00	\$360,000.00
15 16 17 Shop sized to hold 80% of the fleet in				
16 17 Shop sized to hold 80% of the fleet in				
17 Shop sized to hold 80% of the fleet in			Total	\$57,042,000.00
40 Hadaca and a the landt of the second of	e fleet indoors with	a 100% for adm	inistrative offices, t	ueling, and heavy
10 Intuovi space with the length of the Dualmode bus, ou, width 6.5 and 14 lanes	Dualmode bus, 60', wic	Ith 8.5' and 14' lane	Sé	

_	A	ന	o	٥
· · ·				
T	1			
	3 Frisco Facility for Inspection, Overhaul, light and heavy maintenance			
4	and cleaning with yard capacity for 40% of the fleet	Quantity	Per Unit Cost Cost	Cost
5	Indoor Square Foot	211,916.25	\$ 105.00	\$ 22,251,206.25
9	Miscellaneous Equipment and furnishings	-	\$ 250,000.00	\$ 250,000.00
				ч Ф
- 1			sub total	\$ 22,501,206.25
6	Project Construction Items			
	10 Item Description	Quantity	Per Unit Cost Cost	Cost
÷				۰ ج
12				۰ ب
2				•
14			Total	\$ 22.501.206.25
15				
	16 An additional 15% was added to the floor snace			

Genwood Facility for light car maintenance and cleaning with yard capacity for 10% of the fleetCCCleaning with yard capacity for 10% of the fleetQuantityPriceIIndoor Square FootS8,218.75105\$Indoor Square Foot58,218.75100\$Miscellaneous Equipment and furnishings1.00100000\$Miscellaneous Equipment and furnishings1.00100000\$Project Construction ItemsNotalityPrice\$Project Construction ItemsQuantityPer Unit Cost\$Item DescriptionQuantityPer Unit Cost\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item DescriptionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction\$Item SubstructionSubstructionSubstruction	-	ζ.		υ		۵
Glenwood Facility for light car maintenance and cleaning with yard capacity for 10% of the fleet <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td></td<>						
Glenwood Facility for light car maintenance and cleaning with yard capacity for 10% of the fleetImage: Cleaning with yard capacity for 10% of the fleetIndoor Square FootQuantityPrice105Indoor Square Foot58,218.75105\$Miscellaneous Equipment and furnishings1.00100000\$Miscellaneous Equipment and furnishings1.00100000\$Project Construction ItemsNotalProtal\$Item DescriptionQuantityPer Unit CostCostItem DescriptionNotalS\$Item DescriptionNotalS\$Item DescriptionNotalS\$Item DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem DescriptionNotalSSItem SNotalSSSItem SNotalSSSItem SNotalSSSItem SNotalSSSItem SNotalSSSItem SNotalSSSItem SNotalSSSItem SNotalSS </td <td>2</td> <td></td> <td></td> <td></td> <td></td> <td></td>	2					
cleaning with yard capacity for 10% of the fleetQuantityPriceIIndoor Square Foot58,218.75705\$Indoor Square Foot58,218.75705\$Miscellaneous Equipment and furnishings1.00100000\$Miscellaneous Equipment and furnishings1.007001\$Project Construction Items00100000\$Item DescriptionQuantityPer Unit CostCostItem Description01001\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description1101\$Item Description111Item Description11						
Indoor Square FootQuantityPriceIndoor Square Foot58,218.75105\$Miscellaneous Equipment and furnishings1.00100000\$Miscellaneous Equipment and furnishings1.00100000\$Project Construction Items01001\$Project Construction Items0uantityPer Unit CostCostItem Description0uantityPer Unit Cost\$Item Description1001000\$Item Description100010001000Item Description100010001000Item Description100010001000Item Description100010001000Item Description1000100010000Item Description100010001000Item Description100010001000Item Description100010001000Item Description100010001000Item Description100010001000Item Description100010001000Item Description1000100010000Item Description1000100010000Item Description10001000010000Item Description100001000010000Item Description100001000010000Item Description100001000010000Item Description1000010000100000Item Description100001	4					
Indoor Square Foot58,218.75105\$Miscellaneous Equipment and furnishings1.00100000\$Miscellaneous Equipment7.001.000\$Project Construction Items222Item DescriptionQuantityPer Unit CostCostItem Tem Description225Item Description225Item Tem Description225Item Tem Tem Tem Tem Tem Tem Tem Tem Tem T	5		Quantity	Price		
Miscellaneous Equipment and furnishings1.00100000\$Image: DescriptionTotalS6,Image: DescriptionDescriptionDescriptionS6,Image: Description <td></td> <td>ndoor Square Foot</td> <td>58,218.75</td> <td>105</td> <td></td> <td>6,112,968.75</td>		ndoor Square Foot	58,218.75	105		6,112,968.75
Project Construction Items Total \$ 6, Project Construction Items Note that the the the the the the the the the th		Miscellaneous Equipment and furnishings	1.00	100000	Ś	100,000.00
Froject Construction Items Total \$ Project Construction Items Quantity Per Unit Cost Cost Item Description Quantity Per Unit Cost Cost Item Description Total \$						
Project Construction Items Quantity Per Unit Cost Item Description Quantity Per Unit Cost Total \$	6			Total	ഗ	6,212,968.75
Project Construction Items Per Unit Cost Cost Item Description Quantity Per Unit Cost Cost Total S	0					
Item Description Quantity Per Unit Cost Cost Total Total \$	-	Project Construction Items				
Total \$	2	Item Description	Quantity	Per Unit Cost	Cost	
Total \$	n				\$	
	4			Total	Ş	6,212,968.75
16	5					
	9					

×

Station	Ons for peak	Peak Hour	Fare Demand	Round up	Minimum	otal	Location	Total by loc
6th & Laurel	564	141	5	5	0	5	1	
6th & Traver Trail	6	1	0	1	0	1	1	
A-Basin	32	8	0	1	0	1	1	
Arapahoe pnR	7	2	0	1	0	1	1	
Arvada	5	1	0	1	0	1	1	
Cold Springs pnR	542	135	5	5	0	5	1	
Denver Union Sta	3430	858	29	29	0	29	1	
DIA	0	0	0	0	1	1	1	
Jefferson Sta	6333	1583	53	53	, O	53	1	
Pena pnR	0	0	0	0	1	1	1	
Westminster NE	6	2	0	1	, O	1	1	
Westminster SW	0	0	Ő	Ó	1	1	1	10
El Rancho	887	222	7	8	0	8	2	10
Blackhawk	244	61	2	3	0	3	2	
Central City	24	6	ō	1	0	1	3	
Empire	362	91	3	4	0	4	3	
US 6 / Gaming	220	55	2	4	0	4	3	1
daho Springs	148	37	2	2	0	2	-	1
Johnson Park	148	38	1		-		4	
Keystone	339		3	2 3	0	2	4	
Vineral Sta	539	2	0	3 1	0	3	4	
Winter Park				•	0	1	4	
	528	132	4	5	0	5	4	1
Georgetown	61	15	1	1	0	1	5	
_oveland Ski	77	19	1	1	0	1	5	
Avon	661	165	6	6	0	6	5	
Bell Tower	29	7	0	1	0	1	5	
CO 9 & French	7	2	0	1	0	1	5	
CO 9 & Watson	919	230	8	8	0	8	5	
Copper Circle	0	0	0	0	1	1	5	
Copper Entrance	0	0	0	0	1	1	5	
Frisco TC	1857	464	15	16	0	16	5	
Silverthorne	1747	437	15	15	0	15	5	
Silverthorne	907	227	8	8	0	8	5	5
/ail TC	583	146	5	5	0	5	6	1
Dotsero	44	11	0	1	0	1	7	
Eagle	128	32	1	2	0	2	7	
Eagle & I-70	326	81	3	3	0	3	7	
Edwards	846	211	7	8	0	8	7	
EGE East	175	44	1	2	0	2	7	
EGE West	10	2	0	1	0	1	7	
Glenwood Springs	1	0	0	1	0	1	7	
Gypsum	122	31	1	2	0	2	7	
Gypsum & I-70	4	1	0	1	0	1	7	
V Glenwood Mall	1	0	0	1	0	1	7	
Vard Road	110	27	1	1	0	1	7	
Volcott	51	13	0	1	0	1	7	2
				to	otal	219		21

Assumptions

20% have purchase tickets prior at Idaho Springs, Frisco, Jefferson, and Vail 10% have purchased tickets prior at stops west of Vail.

Location		Ons/Offs
Jefferson	Route 1	1143.47
Jefferson	Route 2	2460.278
Jefferson	Route 3	2594.767
West Cont	Route 4	4705.464
Jefferson	Route 5	0
West Vail	Route 6	8376.785
West Cont	Route 7	3297.93

2025 Winter Saturday	AM is	6 AM to	10 AM
Dual Mode Bus in Guideway; No IMC	Noon is	10 AM to	3 PM
10 cents per mile	PM is	3 PM to	7 PM
3-7.5 minute peak headways	Night is	7 PM to	6 AM
3-12 minute off-peak headways	-		

Mountain Bus 1W Eastbound: Central City - Westminster

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Central City	24		36	and mentality	64		57		181	
Blackhawk	234	10	413	6	694	11	648	6	1.988	34
US 6/Gaming	1	42	1	45	1	83	1	46	4	216
El Rancho	41	52	54	65	56	117	49	72	200	307
Jefferson Sta	3	165	3	331	2	488	2	525	9	1,510
Ward Road	-	22	, <u> </u>	45		109	T	99	-	276
Arvada	-	5	-	6	-	4	-	4	-	19
Westminster SW			-	-		-	-	-		-
Westminster NE		6	States and	6		5		3		21
Line Totals	303	303	506	506	817	817	756	756	2,382	2,382

Mountain Bus 1W Westbound: Westminster - Central City

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Westminster NE	4	REPERSION	6		4	The second s	4		18	The second second
Westminster SW	-	-	1 -	-	-	_	_ ·	_	-	-
Arvada	2	- '	6	-	6	-	6	-	20	-
Ward Road	122	-	63	-	62	-	78	-	325	_
Jefferson Sta	382	1	278	2	242	2	282	3	1.185	8
El Rancho	147	31	90	35	74	46	70	30	381	143
US 6/Gaming	173	1	137	1	103	1	134	1	547	3
Blackhawk	11	741	6	505	11	413	6	503	34	2,162
Central City		67		44		40		43	TRUES NOW	195
Line Totals	841	841	587	587	502	502	580	580	2.510	2,510

Mountain Bus 1W, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Central City	24	67	36	44	64	40	57	43	181	195
Blackhawk	244	751	419	511	705	424	654	509	2.022	2,195
US 6/Gaming	174	42	138	46	104	84	134	47	551	219
El Rancho	188	83	144	101	130	163	119	103	581	450
Jefferson Sta	385	166	281	334	244	490	284	528	1,194	1,518
Ward Road	122	22	63	45	62	109	78	99	325	276
Arvada	2	5	6	6	6	4	6	4	20	19
Westminster SW	-	-	-	-	-	-	_	_	-	-
Westminster NE	4	6	6	6	4	5	4	3	18	21
Line Totals	1,143	1,143	1,093	1,093	1,319	1,319	1,336	1,336	4,892	4,892

Mountain Bus 2T Eastbound: Winter Park - Denver Tech Center

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Winter Park	528	TRANSITI AND IN	914	The second second	1,386		754		3.582	Rent Party
Empire	4	58	7	41	8	57	8	39	27	194
El Rancho	44	4	59	6	57	9	53	7	212	26
Jefferson Sta	6	506	7	922	3	1,380	4	762	20	3.570
Mineral Sta	-	5	-	5	-	3	- ·	3	-	17
Arapahoe pnR	-	9		13		5		9	-	36
Line Totals	582	582	987	987	1,454	1,454	819	819	3.842	3,842

2025 Winter Saturday

Dual Mode Bus in Guideway; No IMC 10 cents per mile

3-7.5	minute peak headways
3-12	minute off-peak headways

Mountain Bus 2T Westbound: Denver Tech Center - Winter Park

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Arapahoe pnR	3	1	12		8		14		36	
Mineral Sta	3	-	5		5	-	5	-	18	-
Jefferson Sta	1,327	1	767	6	474	4	408	7	2,976	17
El Rancho	279	32	36	41	102	50	31	37	448	161
Empire	268	6	250	5	95	5	133	3	745	19
Winter Park	and summing	1,839	C. C. D. Market	1,018		625	an at a	544		4,025
Line Totals	1,879	1,879	1,069	1,069	684	684	590	590	4,223	4,223

Mountain Bus 2T, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Winter Park	528	1,839	914	1,018	1,386	625	754	544	3,582	4,025
Empire	272	64	257	46	102	62	140	42	772	213
El Rancho	322	36	95	47	159	59	84	44	660	186
Jefferson Sta	1,332	507	774	928	478	1,384	412	768	2,996	3,587
Mineral Sta	3	5	5	5	5	3	5	3	18	17
Arapahoe pnR	3	9	12	13	8	5	14	9	36	36
Line Totals	2,460	2,460	2,056	2,056	2,138	2,138	1,410	1,410	8,064	8,064

Mountain Bus 3T Eastbound: Arapahoe Basin - Denver Tech Center

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
A-Basin	32		157		377		187	CEALD PYRC	752	
Keystone	338	0	729	1	1,546	1	735	1	3,348	3
Silverthorne	45	139	55	175	73	202	59	162	233	678
Loveland Ski	22	14	54	7	278	5	63	5	419	31
Georgetown	15	5	34	8	41	10	41	7	131	30
Idaho Springs	37	5	86	8	108	11	105	8	337	31
El Rancho	44	5	59	9	57	16	53	11	212	41
Jefferson Sta	6	358	7	954	3	2,232	4	1,042	20	4,585
Mineral Sta	-	5	- 1	6	-	4	-	3	-	18
Arapahoe pnR	Reptile English	9		14	NET OF THE Y	5		9		37
Line Totals	540	540	1,181	1,181	2,483	2,483	1,248	1,248	5,453	5,453

Mountain Bus 3T Westbound: Denver Tech Center - Arapahoe Basin

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Arapahoe pnR	3		12		8		14		37	
Mineral Sta	3	-	6	-	5	-	5	-	19	-
Jefferson Sta	1,919	1	641	5	414	3	401	6	3,375	15
El Rancho	76	32	43	41	16	50	28	37	163	159
Idaho Springs	37	78	43	58	35	60	19	39	134	235
Georgetown	8	33	7	24	6	22	6	16	27	96
Loveland Ski	2	271	7	70	13	36	7	44	29	421
Silverthorne	545	60	422	43	226	40	290	32	1,483	175
Keystone	1	1,680	2	799	2	455	1	507	6	3,441
A-Basin		439	4. A.	142		59	L Mathing & STAV	88		729
Line Totals	2,595	2,595	1,183	1,183	725	725	769	769	5,272	5,272

2025 Winter Saturday Dual Mode Bus in Guideway; No IMC 10 cents per mile

3-7.5 minute peak headways 3-12 minute off-peak headways

Mountain Bus 3T, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
A-Basin	32	439	157	142	377	59	187	88	752	729
Keystone	339	1,680	731	800	1,547	456	736	508	3,354	3,444
Silverthorne	590	198	477	218	299	242	349	194	1,716	853
Loveland Ski	25	285	61	78	291	40	70	49	447	452
Georgetown	23	39	42	32	47	32	47	24	158	125
Idaho Springs	75	83	129	66	144	71	124	47	471	266
El Rancho	120	37	102	50	73	65	81	48	375	200
Jefferson Sta	1,925	359	648	959	417	2,235	405	1,048	3,395	4,600
Mineral Sta	3	5	6	6	5	4	5	3	19	18
Arapahoe pnR	3	9	12	14	8	5	14	9	37	37
Line Totals	3,135	3,135	2,364	2,364	3,208	3,208	2,017	2,017	10,724	10,724

Mountain Bus 4W Eastbound: Breckenridge - Westminster

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Bell Tower	29		164		108		156		458	対理にない思想
CO 9 & French	7	-	16	-	22	-	20	-	65	-
CO 9 & Watson	919	-	1,099	- 1	2,304	-	1,018	-	5,339	-
Frisco TC	248	451	271	370	401	629	268	367	1,188	1,817
Silverthorne	40	310	89	505	63	984	104	550	296	2,349
Loveland Ski	21	21	127	15	276	10	154	11	578	58
El Rancho	41	30	54	17	56	16	49	16	200	79
Jefferson Sta	3	487	3	905	2	1,585	2	821	9	3,797
Ward Road	-	1	-	1	-	0	-	0	-	2
Arvada	-	5	-	5	-	3	-	3	-	16
Westminster SW	-	-	- 1	-	-	-	- 1	-	-	-
Westminster NE		6		5		3		2		16
Line Totals	1,309	1,309	1,822	1,822	3,232	3,232	1,771	1,771	8,133	8,133

Mountain Bus 4W Westbound: Westminster - Breckenridge

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Westminster NE	3		4		4		3	ESV(STATES	14	
Westminster SW	-	-	-	-	-	-	-	-	-	-
Arvada	2	-	5	-	5	-	5	-	17	-
Ward Road	0	-	0	-	0	-	0	-	1	-
Jefferson Sta	1,520	1	508	2	496	2	279	2	2,804	7
El Rancho	16	31	11	35	10	46	8	30	45	142
Loveland Ski	4	270	12	68	19	34	10	43	45	415
Silverthorne	867	49	537	34	345	32	406	25	2,155	139
Frisco TC	985	428	689	319	550	282	509	215	2,732	1,244
CO 9 & Watson	-	2,514	-	1,209	-	985	-	837	-	5,545
CO 9 & French	-	30	-	23	-	13	-	16	-	82
Bell Tower		75	*	76		35	H	52		238
Line Totals	3,397	3,397	1,765	1,765	1,429	1,429	1,221	1,221	7,812	7,812

2025 Winter Saturday

Dual Mode Bus in Guideway; No IMC

10 cents per mile 3-7.5

minute peak headways

3-12 minute off-peak headways

Mountain Bus 4W, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Bell Tower	29	75	164	76	108	35	156	52	458	238
CO 9 & French	7	30	16	23	22	13	20	16	65	82
CO 9 & Watson	919	2,514	1,099	1,209	2,304	985	1,018	837	5,339	5,545
Frisco TC	1,233	878	959	689	951	912	776	582	3,919	3,061
Silverthorne	907	358	625	539	408	1,016	510	574	2,451	2,488
Loveland Ski	25	292	139	83	295	45	164	54	623	473
El Rancho	57	60	64	52	66	62	57	46	244	220
Jefferson Sta	1,523	487	511	907	497	1,586	281	824	2,813	3,804
Ward Road	0	1	0	1	0	0	0	0	1	2
Arvada	2	5	5	5	5	3	5	3	17	16
Westminster SW		-	-	-	-	-	-	-	-	
Westminster NE	3	6	4	5	4	3	3	2	14	16
Line Totals	4,705	4,705	3,587	3,587	4,661	4,661	2,991	2,991	15,945	15,945

Mountain Bus 5D Eastbound: Vail - Denver International Airport

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Vail TC								CHORSE!	-	S. Carlo
Copper Entrance										-
Copper Circle	San						E		-	
Copper Entrance			-	2				-	•	
Frisco TC		0		0/-0			1		-	-
El Rancho										-
Jefferson Sta									-	
Stapleton TC	Contraction of the									
Pena pnR			-	-					-	
DIA					Sales Such		Share New York			-
Line Totals	-	-	-	-	-	-	-	-	-	-

Mountain Bus 5D Westbound: Denver International Alrport - Vail

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
DIA								AR SHOT	-	WARD SA
Pena pnR	Distant - Real		State of the state	-						
Stapleton TC		18.0	General State				-	- Alt		
Jefferson Sta			1							-
El Rancho			1						-	
Frisco TC									-	-
Copper Entrance									-	
Copper Circle									-	
Copper Entrance	Constant P. Land				-	•				
Vail TC			de che constant de la				and the second second second			-
Line Totals	-	-	-	-	-	-		-	-	-

2025 Winter Saturday Dual Mode Bus in Guideway; No IMC 10 cents per mile 3-7.5 minute peak headways 3-12 minute off-peak headways

Mountain Bus 5D, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Vail TC	-		-	-	-	-	12	-		
Copper Entrance	-	-	-	-	-	-	-	-	-	-
Copper Circle	-	-	-	-	-		-	-	-	-
Copper Entrance		-	-		-	-	-	-	-	
Frisco TC	-	-		-	-	-		-	-	-
El Rancho	-	-	-	-	-	-	-	-	-	· · ·

Jefferson Sta	-		-	- 1		- L	- 1	-	I -	-
Stapleton TC Pena pnR		-		-	100 - 			-		-
DIA	-	-			-		The contract of the second	-	A ROAD AND AND AND AND AND AND AND AND AND A	and total of
Line Totals	-	-	-	-	-		-	-		

Note:

indicates no stop assumed at this location; line is retained for spreadsheet structure
 indicates no stop was coded at this location during this run

Mountain Bus 6U Eastbound: West Glenwood Springs - Denver Union Station

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Dally Offs
W Glenwood Mall	-		-	A State of the second	-	-		da da seguine		Here and the second
Johnson Park	151	-	111	-	137	-	103	_	502	-
6th & Traver Trail	6	- 1	18	-	21		23	-	67	
6th & Laurel	564	- 1.	572	-	672		335	_	2,145	-
Glenwood Springs	1	-	2	4	2	-	2	4	7	8
Dotsero	6	2	8	5	7	7	7	5	28	18
Gypsum & I-70	2	0	2	1	2	2	2	1	9	4
Gypsum	50	11	56	32	38	80	55	40	200	163
EGE West	10	0	21	1	8	0	10	1	50	2
EGE East	125	46	103	62	97	70	66	52	392	230
Eagle	62	44	31	37	37	76	20	40	150	196
Eagle & I-70	241	43	210	73	99	126	87	79	636	321
Wolcott	36	11	49	13	32	15	23	8	140	47
Edwards	734	167	609	117	512	196	360	117	2,215	597
Avon	420	270	340	226	273	271	179	208	1,211	975
Vail TC	549	193	517	190	511	147	291	150	1,869	680
Frisco TC	74	687	254	411	425	531	279	356	1,032	1,984
El Rancho	83	39	138	33	110	48	133	27	464	148
Jefferson Sta	230	673	532	151	770	633	510	75	2,042	1,531
Cold Springs pnR	1	113	3	339	3	240	4	266	2,042	958
Denver Union Sta		1,048	SM THE SA	1,881	SHARINAHAR	1,315	(1955) - ADMAN	1,062	CARDING COMPANY	5,306
Line Totals	3,347	3,347	3,575	3,575	3,757	3,757	2,489	2,489	13,168	13,168

2025 WinterSaturdayDual Mode Bus in Guideway; No IMC10 cents per mile3-7.53-12minute peak headways

Mountain Bus 6U Westbound: Denver Union Station - West Glenwood Springs

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Denver Union Sta	2,173		1,962		1,136		981	Contraction of the	6,251	1. Aller and a second
Cold Springs pnR	282	0	216	0	158	0	146	0	802	0
Jefferson Sta	784	230	528	443	547	89	230	300	2.089	1,062
El Rancho	18	386	10	235	14	209	6	195	48	1,025
Frisco TC	722	1,038	556	507	787	231	455	287	2,521	2,063
Vail TC	181	775	219	530	196	623	206	300	802	2,228
Avon	241	383	187	443	209	358	142	245	780	1,428
Edwards	206	681	116	642	177	651	113	391	612	2,365
Wolcott	21	33	14	44	13	24	8	17	56	118
Eagle & I-70	121	181	67	230	48	242	56	125	294	779
Eagle	80	20	30	30	31	49	23	29	163	129
EGE East	70	74	77	97	47	85	40	70	235	327
EGE West	1	17	4	25	4	14	4	11	13	67
Gypsum	86	30	33	42	16	53	24	41	159	167
Gypsum & I-70	2	2	1	2	1	2	1	2	4	8
Dotsero	43	6	16	8	27	7	11	6	97	27

Glenwood Springs	-	2	-	3		2	_	2	-	9
6th & Laurel	-	987	-	626	_	611	-	315	-	2,538
6th & Traver Trail	, -	22	-	20	-	10	-	14	-	66
Johnson Park	-	162	-	109	-	150	-	96	-	517
W Glenwood Mall	24.13.13.13.13.13.13.13.13.13.13.13.13.13.	- 1		- 8	Cores Avenue	- 1	HOAN WEEKS	1		-
Line Totals	5,030	5,030	4,035	4,035	3,412	3,412	2,448	2,448	14,925	14,925

Mountain Bus 6U, Both Directions

1

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Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
W Glenwood Mall		-				•		-	-	
Johnson Park	151	162	111	109	137	150	103	96	502	517
6th & Traver Trail	6	22	18	20	21	10	23	14	67	66
6th & Laurel	564	987	572	626	672	611	335	315	2,145	2,538
Glenwood Springs	1	2	2	7	2	2	2	6	7	17
Dotsero	49	8	23	12	34	14	18	11	124	45
Gypsum & I-70	4	2	3	3	3	4	3	3	13	13
Gypsum	136	41	89	74	54	133	79	81	359	330
EGE West	11	17	25	26	12	14	15	12	62	69
EGE East	195	120	180	159	145	155	107	122	626	557
Eagle	142	64	61	67	67	125	43	69	313	324
Eagle & I-70	362	224	277	303	147	369	143	204	929	1,100
Wolcott	57	43	63	57	46	39	31	25	196	164
Edwards	940	849	725	759	689	847	473	508	2,827	2,962
Avon	661	653	527	669	482	629	321	453	1,992	2,403
Vail TC	729	969	736	721	708	770	497	449	2,670	2,908
Frisco TC	797	1,724	810	918	1,212	762	734	643	3,553	4,047
El Rancho	101	425	148	268	124	258	139	222	512	1,173
Jefferson Sta	1,014	903	1,059	594	1,317	722	740	375	4,131	2,594
Cold Springs pnR	283	113	219	339	161	240	149	266	812	959
Denver Union Sta	2,173	1,048	1,962	1,881	1,136	1,315	981	1,062	6,251	5,306
Line Totals	8,377	8,377	7,611	7,610	7,169	7,169	4,936	4,937	28,092	28,093

2025 Winter Saturday

Dual Mode Bus in Guideway; No IMC

10 cents per mile

3-7.5 minute peak headways 3-12

minute off-peak headways

Mountain Bus 7U Eastbound: Frisco - Denver Union Station Local

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Frisco TC	291		452	Section Street	650		462	-	1,854	
Silverthorne TC	58	194	111	174	90	193	126	160	385	721
Loveland Ski	24	18	132	9	282	5	158	6	596	39
Georgetown	26	6	70	10	54	12	81	10	231	37
Empire	17	18	23	20	19	32	22	21	81	91
Idaho Springs	73	10	170	16	133	19	200	15	576	60
US 6 / Gaming	1	63	1	43	1	52	1	38	4	196
El Rancho	83	5	138	9	110	15	133	11	464	39
Jefferson Sta	230	111	532	65	770	488	510	74	2,042	739
Cold Springs pnR	1	69	3	287	3	257	4	332	12	945
Denver Union Sta		309	1 i i	1,001		1,039		1,030		3,379
Line Totals	804	804	1,634	1,634	2,111	2,111	1,698	1,698	6,246	6,246

Mountain Bus 7U Westbound: Denver Union Station - Frisco Local

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Denver Union Sta	1,257		1,448	2.0	365		917		3,987	
Cold Springs pnR	258	0	227	0	122	0	174	0	780	0

Jefferson Sta	625	3	264	27	211	10	174	33	1,274	73
El Rancho	15	93	10	185	8	136	7	157	40	571
US 6 / Gaming	44	85	43	92	64	51	39	97	189	325
Idaho Springs	17	127	16	248	15	123	13	169	62	666
Empire	73	266	50	267	62	100	43	143	227	776
Georgetown	12	56	11	98	9	43	8	67	40	264
Loveland Ski	3	424	9	178	17	56	9	112	39	769
Silverthorne TC	192	383	197	452	174	109	154	291	717	1,236
Frisco TC		1,056		729		421	Wie spectary	469		2,675
Line Totals	2,494	2,494	2,275	2,275	1,049	1,049	1,538	1,538	7,355	7,355

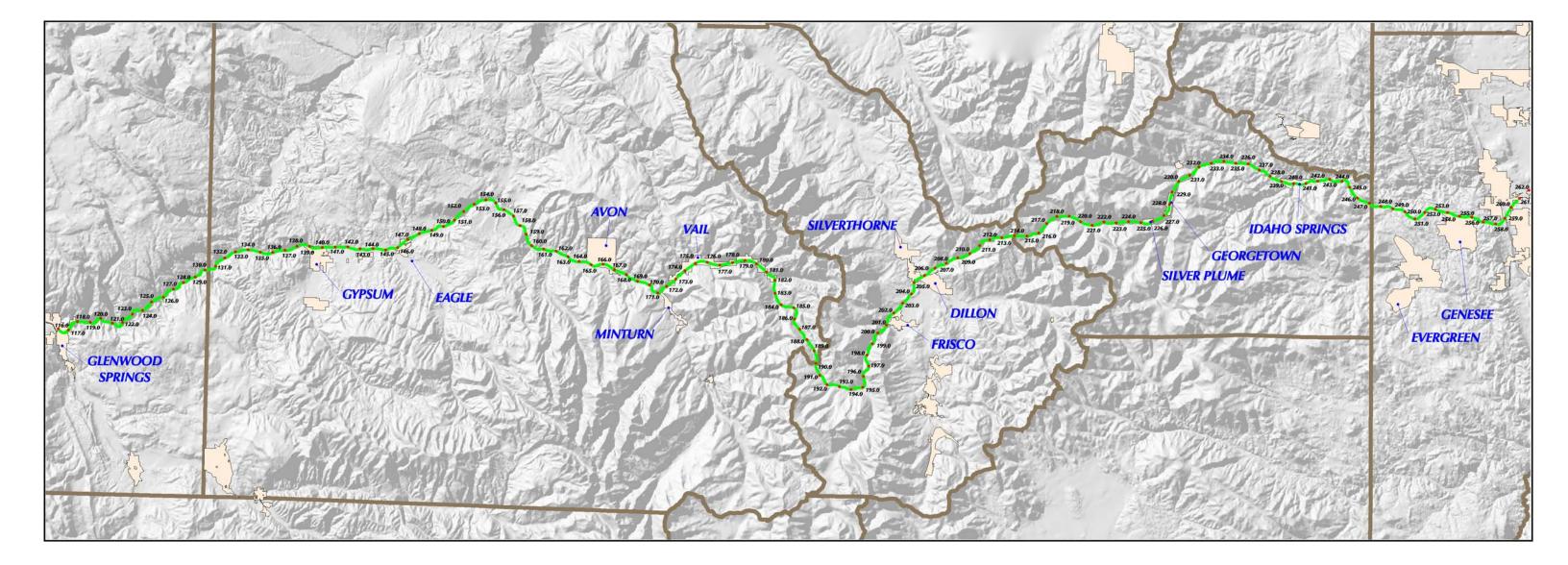
Mountain Bus 7U, Both Directions

Station	AM Ons	AM Offs	Noon Ons	Noon Offs	PM Ons	PM Offs	Night Ons	Night Offs	Daily Ons	Daily Offs
Frisco TC	291	1,056	452	729	650	421	462	469	1,854	2,675
Silverthorne TC	250	577	309	626	264	302	280	451	1,102	1,956
Loveland Ski	27	442	142	187	299	61	167	118	635	808
Georgetown	38	62	81	108	63	55	90	77	272	302
Empire	90	284	73	287	80	132	65	164	308	867
Idaho Springs	90	137	187	263	148	142	213	184	638	726
US 6 / Gaming	45	149	44	135	65	103	40	135	193	521
El Rancho	98	97	148	194	118	151	140	168	504	610
Jefferson Sta	855	115	795	91	982	498	684	108	3,316	812
Cold Springs pnR	259	69	230	287	125	257	178	332	792	945
Denver Union Sta	1,257	309	1,448	1,001	365	1,039	917	1,030	3,987	3,379
Line Totals	3,298	3,298	3,908	3,909	3,159	3,160	3,235	3,235	13,601	13,601

Transfers at Jefferson Station

AM Pea	k Period	Noon	Noon Period		k Period	Night	Period	Da	ily
EB Ons	WB Offs	EB Ons	WB Offs	EB Ons	WB Offs	EB Ons	WB Offs	EB Ons	WB Offs
478	237	1,082	485	1,550	109	1,031	352	4,142	1,184
	237		485		109		352		1,184

Appendix F Colorado Department of Transportation I-70 Mountain Corridor PEIS Level 2 Screening Alternatives Comparison March 2001 This page intentionally left blank.



DRAFT

I-70 Mountain Corridor PEIS Level 2 Screening Alternatives Comparison

March 21, 2001

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1 - STEPS OF LEVEL 2 SCREENING

Steps in Level 2 Screening

Background

This document provides an explanation of the Level 2 Screening Process and initial findings. This effort follows the initial level of screening, where alternatives were screened if they did not provide any potential to meaningfully reduce congestion of improve mobility in the I-70 Mountain Corridor. Criteria for Level 2 Screening have been developed in response to the comments from Public Scoping and direction from the Federal Highway Administration (FHWA), the Colorado Department of Transportation (CDOT), the Environmental Protection Agency (EPA), the U. S. Army Corps of Engineers (COE), the Technical Advisory Committee (TAC), and the Mountain Corridor Advisory Committee (MCAC).

Alternatives have been organized in response to the I-70 Mountain Corridor Major Investment Study (MIS) Vision. "Families" of alternatives include Fixed Guideway Transit (FGT), Rubber Tire Transit (RTT), Highway and Interchange Elements, Transportation System Management (TSM), Aviation, and Alternate Routes. The purpose of "screening" is to select options within the Families of alternatives that best meet the purpose and need for the project. Need–related criteria address factors related to congestion, capacity and mobility. Criteria related to project purposes include safety, implementation (cost, technology, contractibility, and energy requirements), environmental sensitivity and community values.

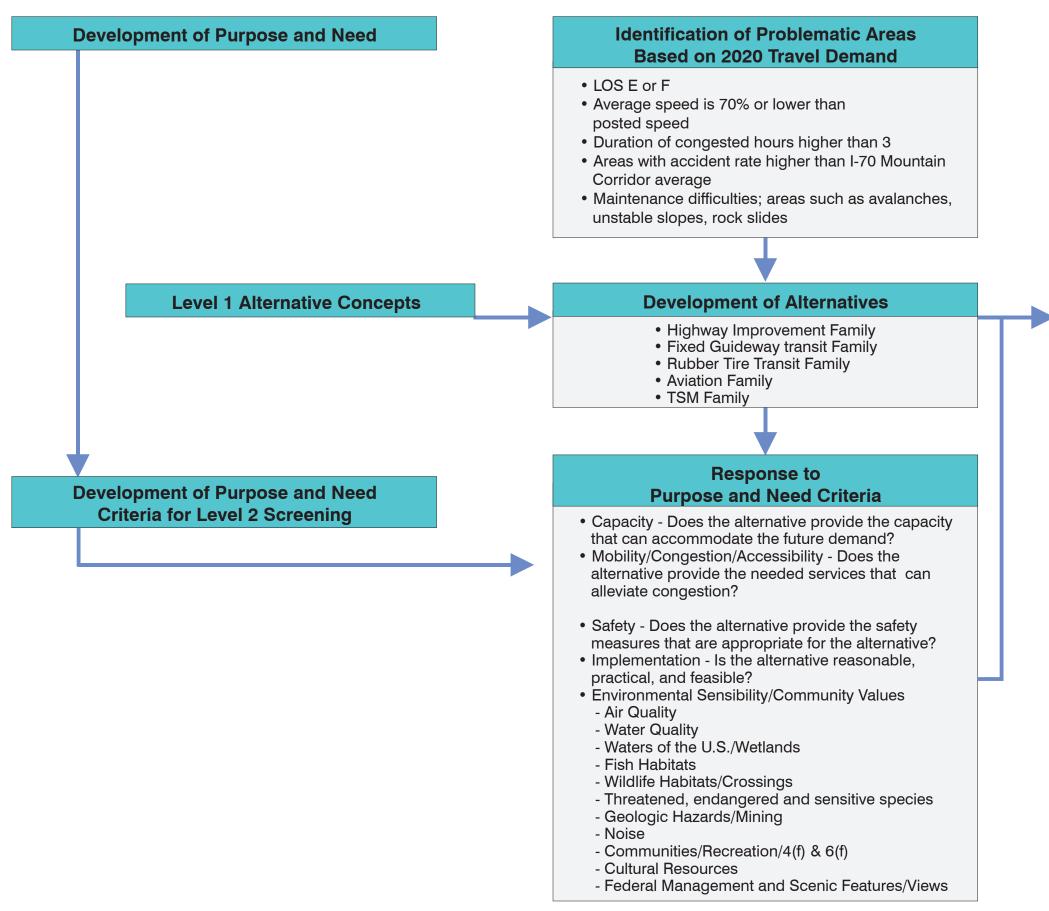
With the exception of Alternate Routes, each of the Families of alternatives will be carried into the Draft PEIS. Alternatives in the Draft PEIS will be organized into "packages" of transportation modes that will include options that represent each of the Families of alternatives. Environmental studies of the intermodal packages of alternatives will include impact assessments of direct, indirect and cumulative impacts, as well as mitigation planning.

Document Organization

This document provides initial findings for each of the alternatives under study, and is intented to facilitate discussions for the TAC and MCAC meetings on March 19 and 21. The process is described on the following diagram. This document is organized into the following sections, (please refer to the table of contents) including:

- Screening Criteria
- FGT Alternatives
- RTT Alternatives
- Highway Alternatives
- TSM Alternatives
- Aviation
- Summary of Environmental Screening Analysis

I-70 PEIS Steps and Flow Chart of Level 2 Screening



Level 2 Screening of Alternatives

- Based on criteria of Purpose and Need
- Use available data and mapping
- Use GIS database as screening tool
- Use TransCAD and VISSIM or tool for Mobility/Congestion Analysis
- Perform Spatial Analysis



Determine Alternatives to be Developed in P DEIS



2 - SCREENING CRITERIA

	Criteria	Assumptions	Highest	Highest to Intermediate	Intermediate	Intermediate to Lowest	Lowest
	System Capacity	System capacity is based on conceptual ridership plans. The range is from an inability to provide seats for all passengers in peak direction during peak hours in opening year to an ability to provide seats for al peak hour passengers in peak direction forecast for year 20.	Significantly exceeds year 2020 demand	Somewhat exceeds year 2020 demand	Accommodates year 2020 demand.	Provides seats for opening year demand but not year 2020 demand.	Does not provide seats for all passengers in peak direction during peak hours in opening year demand.
	System Attractiveness	The relative attributes of the system technology to attract ridership based on the amenities and ride quality, including curvature, noise, food service, baggage handling, and susceptibility to weather conditions.	Vehicles in a guideway have higher ride quality, due to lower curvature, and quiet electric motors. Vehicles with food service, not as susceptible to weather conditions and full baggage handling.				Low ride quality is based on vehicles on the roadway in mixed traffic, greater curvature in the route, and high interior noise from power type and operations. Low amenities include vehicles with no food service, trip highly susceptible to weather and no baggage handling.
NEED	Average Speed	Average Speed in mph including stops/dwell for 10 stops - time based on Vail to C-470 or Golden trip times.	> 60 mph	50 to 60 mph	40 to 50 mph	30 to 40 mph	<30 mph
	Connectivity	Connectivity in number of transfers required between modes. The "ideal" is origin to destination with no transfer between transit vehicles at either of the Mountain Corridor journey.	No transfer required at either end (no transfer).		Transfer required at one end (1 transfer)		Transfers required at both ends (2 or more connections)
	Feeder/Distributor Requirements	Feeder/Distributor Requirements in percent change in vehicle miles from that presently used for local transit services in the Corridor.	Feeder systems in existence or no feeder system needed. Minimal change in local transit services required in the corridor. Utilizes these existing feeder systems as their network.		Feeder systems in existence. Moderate change in local transit services required in the corridor.		New feeder systems required. Significant change in local transit services required in the corridor.
SAFETY	Safety System	System Safety - Measures relative safety of the transit alternative considering the relative potential for crashes.	Heavy weight (FRA compliant) rail vehicles on new alignment	Middleweight rail vehicles on new alignment	Use of buses with prof. drivers only on guided transitway. Lightest weight rail vehicles on new alignment.	Use of buses with professional drivers only on transitway.	Mixed traffic, including vans (with lightweight construction).
	Initial Infrastructure Cost	Including associated highway improvements over a 50 year period.	<\$10M/mile	\$10-15M/mile	\$15-20M/mile	\$20-25M/mile	>\$25M/mile
IMPLEMENTATION	Technology Availability	Criteria range from technologies that are currently available to operate within the corridor to technologies that are currently in the developmental or research stage. The range in between covers any modifications required to existing technologies for operation in the corridor. An additional factor relates to the percent grade that given technologies are capable of operating within.	System is able to operate in the corridor without modifications.		Technology exists but requires modifications.		System is in the research and development stage.
	Fuel Availability	Identifies whether linehaul mode uses petroleum-based fuel (with its currently available supply and established production and distribution system), or has a heavy use of electricity, (which is presently dependent on relatively limited production and generation capabilitie and the potential difficulty/expense in providing needed additional capacity.)		Uses existing facilities with some modifications	Uses some existing facilities and some new infrastructure	Uses mostly new infrastructure	Uses all new infrastructure.
	Fuel Limitations	Federal Policy dictate that transit systems minimize the use of non- renewable fuel sources. This criteria measure whether the proposed system is capable of using non-renewable fuels.	Uses multiple, renewable fuel resources	Uses renewable fuel resources,	Uses a combination of non-renewable and renewable fuel resources	Uses mostly non-renewable fuel resources,	Uses only non-renewable fuel resources (fossil fuels).
	Energy Consumption	Relative rating based on system power requirements. Diesel fuel is assumed at \$1.60/gal. Electrical energy is assumed at \$0.10/kWH.	<\$0.01/seat-mile	\$0.01-0.05/seat-mile	\$0.05-0.10/seat-mile	\$0.10-0.15/seat-mile	>\$0.15/seat-mile

I-70 Mountain Corridor PEIS Level 2 Screening Criteria Measures Values for FGT and RTT Alternatives

	Criteria	Assumptions	Highest	Highest to Intermediate	Intermediate	Intermediate to Lowest	Lowest
—	Criteria	Assumptions	Highest	Intermediate	Intermediate	to Lowest	Lowest
NEED	System Capacity	Measured as the ratio between the traffic volume as projected by TransCAD Model and the capacity of highway as the result of proposed action at various sections of I-70. The capacity of highway is determined by the grade, width of lane and shoulders, horizontal and vertical curvatures, and other roadway features as specified in the Highway Capacity Manual (HCM).	LOS A (0.29 and below) LOS B (0.29 - 0.43)	LOS C (0.44 - 0.65)	LOS D (0.66 - 0.84)	LOS E (0.85 - 1.00)	LOS F (Above 1.00)
NE	Speed	Speed in mph is calculated using the software VISSIM. VISSIM can determine the average speed of vehicles based on the travel demand from forecast model and the roadway features.	100% or above free flow speed	85 - 99% of free flow speed	68 - 84% of free flow speed	50 - 68% of free flow speed	50% or less than free flow speed
	Duration of Congested Hours	Duration of Congested Hours is calculated as the length of time at a section of I-70 where the LOS of that section is continuously E or F.	0 hours of continuous LOS E or F	0 - 1 hour of continuous LOS E or F	1 - 2 hours of continuous LOS E or F	2 - 4 hours of continuous LOS E or F	Above 4 hours of continuous LOS E or F
SAFTEY	Safety System	Safety criteria relate to the evaluation of potential improvements in safety which might result from changes in the highway cross-section and potential changes in the alignment of I-70. Safety improvement results in an estimate of accident reduction rates attributed to widening the highway from four to six lanes. Further accident reduction rates would result from providing wider shoulders and various median treatments.	Reduction of accident 40% and higher	Reduction of accident 25 - 39%	Reduction of accident 20 - 25%	Reduction of accident 10 - 19%	Reduction of accident 0 - 9%
IMPLEMENTATION	Initial Infrastructure Costs	Cost is based upon an initial study of the estimated capital construction cost for the alternative (average \$million/mile basis, including lane widening, tunnel capacity improvements & structured lanes). The environmental mitigation cost is not included in this estimate.	Less than \$15 million/mile	\$15 - 20 million/mile	\$20 - 25 million/mile	\$25 - 30 million/mile	Above \$30 million/mile Costs for alternative - 160 million/mile
	Measures relate to the difficulty of constructing the alternatives, based on professional judgment and past construction experience. Constructibility measures include the amount of construction detours required, length of construction duration, need for special construction equipment, disposal of waste materials, acquisition of construction materials and labor, obtaining special construction procedures prohibited by adverse weather conditions, construction workers' physical condition due to a high altitude work site, and many other construction related issues.		Least difficult		Moderately difficult		Most difficult

RESOURCES		CONFLICT CRITERIA ¹	ASSUMPTIONS	APPLICABLE FEDERAL, STATE REGULATIONS ²	
			 The relative change in tons/day of COx, NOx, and PM10 is directly related to the average daily traffic. The evaluation for highway alternatives will be to examine the change in traffic volumes for each alternative and use this number to determine mobile emissions and particulate matter. These values will be compared to the baseline conditions by calculating COx, NOx, and PM10 using traffic volumes from the year 2000. 		
A in (molity	Potential for conflict is based on the change in COx, NOx, or PM10 in tons/day relative to current (baseline) conditions. The relative change in mobile emissions and particulate matter for each highway alternative, will be determined through	 Calculations will use traffic counts from 2000 at the Twin Tunnels and model projections fro the highway segments between Idaho Springs and Empire. 	NAAQS are currently not exceeded in the study area (except Jefferson County) therefore most of the area is an attainment area. There is not sufficient air quality monitoring the 5 counties along 1-70 to provide a baseline for analysis (there are no monitoring stations in Clear Creek County and incomplete monitoring data from stations	
Air (Quality	change in average daily traffic relative to the baseline calculations.	3. The difference between the no action alternative for 2020 and the action alternatives for 2020 is most useful when compared to the year 2000 baseline.	further west). The team is developing baseline mobile emissions based on the travel demand model and is working closely with the CDPHE and the EPA to create a customized approach that considers topography, weather, and travel characteristics for air quality modeling during the Draft PEIS.	Iden
			4. The percentage of SUV, automobiles and trucks is consistent throughout this segment of highway.		
			5. The air quality quantitative analysis will be refined in the Draft PEIS and will consider additional factors as well as evaluate impacts due to multi-modal combinations of alternatives.		
	Rockfall	Potential for conflict is based on adverse impacts on existing rockfall hazards. An adverse impact would result if	Rock fall hazard delineated from aerial photo interpretation and published data.		Iden
		increased potential for rockfall hazard to effect safety, service, and mobility of the transportation facility.	 Cursory field observations performed to verify presence/absence. Mitigation methods may provide only partial protection. 		
		Potential for conflict is based on adverse impacts on existing debris/mudflow hazards. An adverse impact would result	1. Debris/mudflow hazard delineated from aerial photo interpretation and published data.		
	Debris / Mudflow	if increased potential for existing debris/mudflow hazard affected safety, service, and mobility of the transportation facility. Decease in depositional zone at base of debris fan leads to increased potential for sedimentation of	2. Cursory field observations performed to verify presence/absence.		Iden
Geological		waterways/wetlands.	3. Mitigation methods may provide only partial protection.		
Hazards	Landslide	Potential for conflict is based on adverse impacts on existing landslide hazards. An adverse impact would result if	1. Debris/mudflow hazard delineated from aerial photo interpretation and published data.		Ller
	Landside	increased potential for existing landslide affected safety, service, and mobility of the transportation facility. Disturbance near toe/base of existing landslide will increase potential for future and continued movement.	2. Carsoly near observations performed to rearry presences assence.		Ider
			Mitigation methods may provide only partial protection. Avalanche hazard delineated from aerial photo interpretation and published data.		
	Avalanche	Potential for conflict is based on adverse impact on existing avalanche hazards. An adverse impact would result if	 Avalatic nazare definitiated from actual proof interpretation and published data. Cursory field observations performed to verify presence/absence. 		
		increased potential for existing avalanche affected safety, service, and mobility of the transportation facility. Decease in depositional zone at base of avalanche zone leads to increased potential for conflict.	3. Mitigation methods may provide only partially effective.		Ide
			 Many avalanche hazards cannot be mitigated, and potential impacts may include loss of forested areas and substantial increase in erosion. 		
			I. Mine waste delineated from aerial photo interpretation and published data.		
	Mine Waste	Potential for conflict is based on disturbance of existing mine waste. Disturbance to contaminated mine waste must be	 Some of the mine waste sites in the Idaho Springs area have been classified as Superfund sites. Precise impacts to these sites and other mine waste sites will not be performed in Level 2 screening. 	Comprehensive Environmental Response, Compensation and Liability Act of 1980, Superfund Amendments	
		handled in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980, Superfund Amendments and Reauthorization Act of 1986, Resource Conservation and Recovery Act of 1976, and subsequent amendments in 1984. These documents specify requirements for hazardous materials treatment, storage, transportation, cleanup, industry disclosure, and liability.	3. No field observations performed to verify presence/absence.	and Reauthorization Act of 1986, Resource Conservation and Recovery Act of 1976, and subsequent	Ider
			 Ranking based on presence/absence. If transportation alternative impacts identified mine waste site, 	amendments in 1984 provide the guidance for hazardous materials treatment, storage, transportation, cleanup, industry disclosure, and liability.	Geo
		nansportation, creanup, muusu y usciosure, and naonny.	mitigation will be required in accordance with the above referenced documents.		
			 Amount of material, type of waste product, and cost of cleanup will not be performed under Level 2 screening. 		
		Potential for conflict is based on increase of acidic groundwater flow in mineralized rock areas. An adverse impact would result if disturbance to mineralized rock occurs. Rock excavations may increase fracture flow and transport of	 Mineralized rock zones delineated from aerial photo interpretation and published data, specifically observing mining activity in the area. 		
	Mineralized Rock	organic and inorganic compounds. Low-pH water in these areas is created through chemical reaction of sulfide minerals with water and air. For example, when pyrite is exposed to air and water, it reacts with the oxygen and water to form ferrous sulfate and sulfuric acid. These reactions decrease the pH (creating acidic water) and increase hardness, the concentrations of iron, sulfate, and total dissolved solids in water. Surface or groundwater with a low pH can then leach out metals from the surrounding bedrock, thereby contaminating the water with metals. The concentration and type of	 Field observations performed to verify presence/absence of staining on existing cuts. 	Colorado Department of Public Health and Environment, Water Quality Control Commission, C.R.S. 1973, 25 8-101, as amended. Classifications and Numeric Standards for: South Platte River Basin – Region 3, Clear Creek Basin, Stream Segments 1, 2, 11, 12. Upper Colorado River Basin – Region 12. Blue River Basin, Stream Segments 3, 14. Eagle River Basin, Stream Segments 1, 8, 9.	Ider
Water Quality		principal metal contaminants in Clear Creek are zinc and manganese. Other contaminants that are present include iron, aluminum, copper, cadmium, gold, silver, lead, molybdenum, and uranium.			
			1. Excessive road sand or salt is detrimental to water quality when transported or deposited in streams.		
			2. The highway width is positively correlated (proportionately) to the volume of sand or salt applied for winter maintenance.		
	Winter Maintenance	Potential for conflict is based on the relative usage of sand and magnesium chloride applications adjacent to open waters. Alternatives comparison measure the relative distance (miles of highway) where application of sand and magnesium chloride could negatively impact streams and rivers adjacent to the alternative alignment.	 Sand/salt application rates and the associated potential for conflict are positively correlated with elevation (i.e., application rates increase with elevation). 	Colorado Department of Public Health and Environment, Water Quality Control Commission, C.R.S. 1973, 25 8-101, as amended. Classifications and Numeric Standards for: South Platte River Basin – Region 3, Clear Creek Basin, Stream Segments 1, 2, 11, 12. Upper Colorado River Basin – Region 12. Blue River Basin,	Ideı
			4. The "potential for conflict" is directly proportional to the width of highway - the wider the highway, the higher the potential for conflict.	Stream Segments 3, 14. Eagle River Basin, Stream Segments 1, 8, 9.	
			5. The reference or "baseline" is the existing width of I-70.		
		Potential for conflict is based on the relative increase in impermeable surface areas. Alternatives comparison measure	 Excessive stormwater runoff transports particulates and various contaminants (byproducts of automobile operations along the highway) that are detrimental to stream water quality. 	Section 402(p) of the Clean Water Act. Clarifies that storm water discharges associated with industrial activity to waters of the United States must be authorized by an NPDES permit, to include storm water discharges	Ide
	Stormwater	the relative increase in amount (approximate area) of impermeable surface area directly associated with the widening of	2. The highway width is positively correlated (proportionately) to the volume of stormwater runoff.	associated with construction activity (40 CFR 122.26). Colorado Department of Public Health and Environment, Water Quality Control Commission, C.R.S. 1973, 25-8-101, as amended. Classifications and	visi
	Runoff	highway alternatives. The increase in surface water runoff resulting from the increase in impermeable surface area could negatively impact streams and rivers adjacent to the alternative alignment.	3. The "potential for conflict" is, therefore, directly proportional to the width of the highway	Numeric Standards for: South Platte River Basin – Region 3, Clear Creek Basin, Stream Segments 1, 2, 11, 12. Upper Colorado River Basin – Region 12. Blue River Basin, Stream Segments 3, 14. Eagle River Basin,	imp gre;
			The reference or "baseline" is the existing width of I-70.	Stream Segments 1, 8, 9.	1

	MIS & RELATED ISSUES FROM PUBLIC SCOPING & AGENCY COMMENTS
an for ns	Identified by EPA and in the Clear Creek County Survey.
	Identified in the Clear Creek County Survey and by the Colorado Geological Survey.
	Identified in the Clear Creek County Survey and by the Colorado Geological Survey.
	Identified in the Clear Creek County Survey and by the Colorado Geological Survey.
	Identified in the Clear Creek County Survey and by the Colorado Geological Survey.
b ,	Identified in the Clear Creek County Survey and by the EPA & Colorado Division of Geology.
25-	Identified in the Clear Creek County Survey and by the EPA .
25-	Identified in the Clear Creek County Survey and by the EPA & CDPHE.
ity 12.	Identified in the Clear Creek County Survey and the MIS - The impact of construction of the vision elements is a concern identified throughout the planning process. This includes the impact of the vision due to increased runoff of sediments, deicing chemicals, metals, oil and grease, etc. into proximate streams (ES-10) Identified by the EPA.

ENVIRONMENTAL CRITERIA For Level 2 Screening I-70 Mountain Corridor PEIS

RE	SOURCES	Greatest Potential for Conflict / Critical Environmental & Hazard Issues	Range between Greatest to Intermediate Potential for Conflict	Intermediate Potential for Conflict	Range between Intermediate to Least Potential for Conflict	Least Potential for Conflict
Graphic Legend Air Quality						
		The analysis will provide estimates of mobile emissio	ns and particulate matter associated with proj	ect alternatives. These estimates will be based on year 2000 and 2020 traffic	c volumes for the no action and the highway	alternatives, as well as emissions associated with FGT power sources
	Rock Fall	Evidence of recent activity/ highly fractured bedrock/ rock face at steep angle/ talus below slope/ no catchment beside highway/rockfall rating "4"/ long-term loss of service to highway/ impedance of full roadway/ driver must stop/ immediate mitigation needed/ no mitigation previously done		Somewhat recent activity/ highly fractured bedrock/ little or no talus on slope below/ rock face at moderate to steep angle/ limited catchment area/ rockfall rating "2"/ moderate loss of service to highway/impedance to less than half of the roadway/ driver must slow down/ long-term mitigation needed/ periodic maintenance required/ limited or partial mitigation may have been done in the past		No evidence of recent activity/ rock is not highly weathered/ good catchment area for debris/ rockfall rating "0" or "1"/ little or no loss of service to highway/ impedance of shoulder or less/ no mitigation necessary/ one-time maintenance needed/ extensive mitigation has been done which is mostly effective
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		84 to 161 acres		46 to 84 acres		< 46 acres
	Debris / Mud Flow	Known recent activity/ usually less than 500 feet from the highway/ mud cracks on surface/ young or no vegetation/ usually no buildings present/ long-term loss of service to highway/ impedance of full roadway/ driver must stop/ immediate mitigation needed/ no mitigation previously done		Somewhat recent activity/ usually less than 500 feet from the highway/ deposit visible with thick colluvium on surface/ young vegetation/minor engineering structures / moderate loss of service to highway/ impedance to less than half of the roadway/ driver must slow down/ long-term mitigation needed/ periodic maintenance required/ limited or partial mitigation may have been done in the past.		No evidence of recent activity/ most north-facing slopes with long recurrence intervals (50-100yrs)/ usually greater than 500 feet from highway/ little or no loss of service to highway/ impedance of shoulder or less/ no mitigation necessary/ one-time maintenance needed/ extensive mitigation has been done which is mostly effective
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
Geological Hazards		50 to 72 acres		19 to 54 acres		< 19 acres
	Landslide	Evidence of recent activity/ usually less than 500 feet from the highway/ head scarps, slumps, and hummocky surface/ young vegetation/ tilted fences or utilities/ long-term loss of service to highway/ impedance of full roadway/ driver must stop/ immediate mitigation needed/ no mitigation previously done		Somewhat recent activity/ usually less than 500 feet from the highway/ no visible scarps or slumps, surface is hummocky/ intermediate vegetation/ utilities and fences stand straight/moderate loss of service to highway/ impedance to less than half of the roadway/ driver must slow down/ long-term mitigation needed/ periodic maintenance required/ limited or partial mitigation may have been done in the past		No evidence of recent activity/ usually greater than 500 feet from highway/ no fresh head scarps, surface is hummocky/ vegetation is mature/ utilities and fences stand straight/ little or no loss of service to highway/ impedance of shoulder or less/ no mitigation necessary/ one- time maintenance needed/ extensive mitigation has been done which is mostly effective
		Resource Quantifications > 1 acres	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications <1 acres
	Avalanche	Evidence of recent activity/ usually less than 500 feet from the highway/ well defined, deep chute/ young vegetation/ limited or no runout zone beside highway/ long-term loss of service to highway/ impedance of full roadway/ driver must stop/ immediate mitigation needed/ no mitigation previously done		Somewhat recent activity/ usually less than 500 feet from the highway/ chute is not active every year/ runout zone may or may not reach highway/ moderate loss of service to highway/ impedance to less than half of the roadway/ driver must slow down/ long-term mitigation needed/ periodic maintenance required/limited or partial mitigation may have been done in the past		No evidence of recent activity/ usually greater than 500 feet from highway/ sufficient runout zone, but suspended debris may reach the highway/ little or no loss of service to highway/ impedance of shoulder or less/ no mitigation necessary/one-time maintenance needed/ extensive mitigation has been done which is mostly effective
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		> 6 acres Disturbance in existing mine waste / Extensive observed mining activity		2 to 6 acres Disturbance in existing mine waste / Some observed mining activity		< 2 acres No observed mine waste deposits / Little or no mining activity
	Mine Waste	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		Mine Waste Encountered	ž	No significant change in exposure to mine water, no disturbance of know mine waste material		Mine water may be avoided
	Mineralized Rock	Disturbance in mineralized zones / Extensive observed mining activity		Disturbance in mineralized zones / Some observed mining activity		No observed mineralized zones / Little or no mining activity
Water Quality		Resource Ouantifications Large rock cuts through mineralized zones	Resource Quantifications	Resource Ouantifications No significant change in exposure to mineralized rock	Resource Quantifications	Resource Ouantifications Mineralized rock may be avoided
	Winter Maintenance	Increase in winter sanding or magnesium chloride use		Increase in winter sanding or magnesium chloride use in watershed area		No increase in winter sanding or magnesium chloride use
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
	Stormwater Runoff	50 % Increase Greatest increase in impermeable surface		20% Increase Intermediate increase in impermeable surface		3 to 7% Increase Least increase in impermeable surface
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		50 % Increase		20% Increase		3 to 7% Increase

RESO	URCES	CONFLICT CRITERIA ¹	ASSUMPTIONS	APPLICABLE FEDERAL, STATE REGULATIONS ²	
Wetlands			 Impacts occur when new roadway facilities extend into Waters of the U.S. and wetlands. Roadway facilities include cut and fill for expansion of existing roads, and construction (cut and fill) of roadbeds in a new right-of-way. Alternative footprints that extend out from the existing roadbed and those where new roadbeds are required are used to calculate areas. 		
		Potential for conflict is based on displacement of Waters of the U.S. and wetlands (vegetated wetlands, and fens-seeps- springs). Alternatives comparison measure the approximate amount (acreage) of open and flowing waters, vegetated wetlands, and fens-seeps-springs that have potential to be directly affected by construction of the alternatives.	2. All wetlands will be included in the analysis irregardless of jurisdiction of Section 404 of the Clean Water Act. The COE suggested that instead of Waters of the U.S., this category should specify open and flowing water. However, intermittent streams are currently included in this category.	Section 404 of the Clean Water Act, regulates waters of the U.S. including wetlands; the team is working closely with the COE to ensure that the appropriate level of detail is achieved in order to identify the least damaging, practicable alternative [(404 (b)(1)] in terms of impacts to aquatic resources. Particular attention is given to the displacement of fens, which are a USFWS resource category 1 and an irreplaceable resource without mitigation potential. In addition, Executive Orders 11990 (protection of Wetlands) and 11988	Identi locate Addit Conse
			3. Fens-seeps-springs is recognized as a critical wetland type, but this category will not be weighted in the first determination of conflict, although alternatives that have potential to affect fens-seeps-springs will be marked.	(management of floodplains), relate to screening criteria.	the C
			 Alternatives that have potential to impact fens-seeps-springs, or complexes of vegetated wetlands will be evaluated to avoid or reduce impacts. 		
			 Impact will occur to the fishery resource if the alignment (including catch points and toe of slope) encroaches within 100 feet of the fishery resource. 		
			2. The Colorado Division of Wildlife has not officially designated stream reaches as "high value fisheries", however, discussions with CDOW personnel have resulted in the identification of reaches considered by these individuals as valued fisheries.		
Fishery Resou	rces	Potential for conflict is based on relative potential for impact to Species of Special Concern, Gold Medal Streams, and high value fisheries resources (as defined by the Colorado Division of Wildlife). Alternatives comparison measure relative amount (miles of stream) of fisheries resources with potential for negative impacts resulting from the implementation of alternatives.	3. As described by CDOW personnel "high value fisheries" are considered resources with any of the following attributes: support public recreation and the local economy, support abundant and diverse fish populations, support naturally reproducing trout populations.		Identi
			4. The relative extent of potential fisheries resource impacts or loss will be calculated using existing Geographic Information System (GIS) data and identification of valued fisheries resources provided by CDOW Fisheries Biologists.		
			5. Although mitigation measures may be implemented to reduce or eliminate the potential for impacts to the fisheries resources, for screening purposes, these measures have not been considered.		
			 Use of this criteria in Level 2 screening refers to the additional (or net difference) area of big game range intersected by transportation modes under consideration. 		
	Range	Potential for conflict is based on area of selected big game range intersected by transportation alternatives. Selected big game include mule deer, elk, and bighorn sheep populations along the I-70 Corridor. Range refers to winter, summer, and production areas for these species as defined and delineated by the Colorado Division of Wildlife WRIS and	 Determination of big game range area intersected will be based on a GIS overlay analysis of transportation alternatives with Colorado Division of Wildlife WRIS data. No field studies will be conducted. 		Identi
	0	and production areas for these species as defined and defineated by the Colorado Division of Wildlife WKIS and intersected by alternatives. Area intersected will be in acres.	 Determination of big game range area intersected may change based on subsequent and more refined analyses. 		
			4. Criteria index was calculated by dividing the number of conflict categories (5) into the greatest acreage of biodiversity area intersected by any single alternative.		
		High biodiversity areas are geographic areas exhibiting relatively high biological diversity as defined and delineated by	 Use of this criteria in Level 2 screening refers to the additional (or net difference) biodiversity area intersected by transportation modes under consideration. 	a	
Wildlife	Biological Diversity		 Determination of biodiversity area intersected will be based on a GIS overlay analysis of transportation alternatives with CNHP-designated biodiversity areas. No field studies will be conducted. 	n	Identi
whunte		the Colorado Natural Heritage Program (CNHP).	Determination of biodiversity area may change based on subsequent and more refined analyses.		
			 Criteria index was calculated by dividing the number of conflict categories (5) into the greatest acreage of biodiversity area intersected by any single alternative. 	e 	
			 Use of this criteria in Level 2 screening refers to the additional (or net difference) structural barrier (in linear miles) due to transportation modes under consideration. 		
		Potential for conflict is based on additional miles of structural barrier in designated wildlife crossing areas along the 1-70 corridor. Barriers include structural, operational, and behavioral impediments to wildlife trying to cross the 1-70 corridor. Only structural barriers are included in this screening criteria. Structural barriers include concrete Jersey	 Determination of additional barrier will be based on a GIS overlay analysis of transportation alternatives with wildlife crossing areas designated by the Colorado Division of Wildlife (CDOW). No field studies will be conducted. 		Ident vehic
	Crossings	median barriers, headlight reflectors mounted on concrete median barriers, retaining walls, fences, and road or rail surface. Designated wildlife crossing areas are based on animal vehicle collision data and information from CDOW, CDOT, USFS, BLM, and USFWS.	3. Determination of additional barrier effect may change based on subsequent and more refined analyses.		Clear Junct Identi
			4. Criteria index was calculated by dividing the greatest mileage intersected (by any single alternative) by the number 5 (the number of conflict categories). Where wildlife crossing areas are designated on both sides of I-70, only one side of the highway was used in the calculation to avoid duplicate counting.		
			 Use of this criteria in Level 2 screening refers to the additional (or net difference) structural barrier (in linear miles) intersecting potential lynx habitat and boreal toad breeding habitat lost due to transportation modes under consideration. 		
		for lynx is based on additional miles of structural barrier along I-70 intersecting areas of potential lynx habitat. Barriers include structural, operational, and behavioral impediments to wildlife crossing the I-70 corridor. Only structural barriers are included in this criteria. Structural barriers include concrete Jersey median barriers, headlight reflectors	 Determination of additional barrier and boreal toad habitat lost will be based on a GIS overlay analysis of transportation alternatives. No field studies will be conducted. 		Ident
T&E Species		mounted on concrete median barriers, retaining walls, fence, and road or rail surface. Potential lynx habitat will be identified with data/input from CDOW, USFS, BLM, CDOT, and USFWS. Proximity to confirmed boreal toad breeding sites will be measured in feet from the outer edge of the proposed disturbance footprint associated with each alternative.	3. Determination of additional barrier distance and boreal toad habitat intersected may change based on subsequent and more refined analyses.	Section 7 of the Endangered Species Act. Loss of individuals may affect species viability.	throu of bui Identi
		Potential conflict for Colorado River and Greenback Cutthroat Trout is based on proximity to water bodies identified by	4. Criteria index for lynx was calculated by dividing 5 (the number of conflict categories) into the greatest mileage of additional structural barrier (for any single alternative) intersecting potential lynx habitat. Criteria index for boreal toads was calculated by dividing 5 (number of conflict categories) into the		

	MIS & RELATED ISSUES FROM PUBLIC SCOPING & AGENCY COMMENTS
n is	Identified in the Clear Creek County Survey and the MIS - Construction of the vision will be located within 150 feet of 24 miles of riparian habitat, much of which includes wetlands. Additionally, numerous bridges and culverts will need to be replaced over watercourses. Consequently, there is significant concern regarding wetland impacts. (ES-11) Identified by the COE & EPA.
	Identified in the Clear Creek County Survey and by the USFWS, CDOW, & EPA.
	Identified in the Clear Creek County Survey and by the USFWS, CDOW, & EPA.
	Identified in the Clear Creek County Survey and by the USFWS, CDOW, & EPA.
	Identified in the Clear Creek County Survey and the MIS - Methods to mitigate vehicle/animal accidents will need to be investigated. Concerns are especially pronounced in Clear Creek County where bighorn sheep frequent the I-70 right-of-way, and near Dowd Junction, where accidents with migrating elk on I-70 are an ongoing problem (ES-10). Identified by the USFWS, CDOW, & EPA
	Identified in the Clear Creek County Survey and the MIS - Elements of the vision cross through habitats of T&E species near the Eisenhower Tunnel and over Vail Pass. The effect of building and operating vision elements on these species will need to be addressed. (ES-10) Identified by the USFWS.

ENVIRONMENTAL CRITERIA For Level 2 Screening I-70 Mountain Corridor PEIS

	RESC	OURCES		Greatest Potential for Conflict / Critical Environmental & Hazard Issues	Range between Greatest to Intermediate Potential for Conflict	Intermediate Potential for Conflict	Range between Intermediate to Least Potential for Conflict	Least Potential for Conflict
	Graph	nic Legend						
	Open and Flow		Flowing Waters	Greatest quantity of displacement of waters of the U.S. including wetlands (Quantity does not distinguish functionality, wetland type, or jurisdiction)		Intermediate quantity of displacement of waters of the U.S. including wetlands		Least quantity of displacement of waters of the U.S. including wetlands
				Resource Quantifications > 7 acres	Resource Quantifications 5 to 7 acres	Resource Quantifications 3 to 5 acres	Resource Quantifications 1 to 3 acres	<i>Resource Quantifications</i> < 1 acres
Wetlands		Vegetated	Watlanda	Greatest quantity of displacement of vegetated wetlands (Quantity does not distinguish functionality, wetland type, or iurisdiction)	5 10 7 acres	Intermediate quantity of displacement of vegetated wetlands	1 10 5 acres	Least quantity of displacement of vegetated wetlands
		vegetated	wenands	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
				> 10 acres	7 to 10 acres	4 to 7 acres	1 to 4 acres	< 1 acre
				Greatest quantity of displacement of fen, seep or spring		Intermediate quantity of displacement of fen, seep or spring		Least quantity of displacement of fen, seep or spring
		Fen/Seep/S	Spring	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
				> 0.5 acre		0.1 to 0.5 acre		0 acre
				Greatest length of gold medal fishery water encroached		Intermediate length of gold medal fishery water encroached		Least length of gold medal fishery water encroached
		Gold Med	al Fisheries	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
Fishery Resources	es			> 0.6 mile		0.1 to 0.5 mile		< 0.1 mile
i isher y nesource.	co			Greatest length of high value fishery water encroached		Intermediate length of high value fishery water encroached		Least length of high value fishery water encroached
		High Valu	e Fisheries	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
				> 2.0 miles	1.5 to 1.9 miles	1.0 to 1.4 miles	0.5 to 0.9 mile	0 to 0.4 mile
	Highway & RTT	Range, Biological Diversity, & Crossing		2 I	Alternative creates a partial barrier to wildlife movement, operational impediment, and/or results in a substantially wider road up to 50%	Alternative creates a partial barrier to wildlife movement and results in increased road width up to 25%. Moderate quantity of displacement of range and biological diversity areas	Localized highway alignment resulting in habitat fragmentation	Minimal change to roadway section. Least quantity of displacement of range and biological diversity areas
			Deer & Elk Wintering	Greatest quantity of displacement of elk winter concentrations areas		Moderate quantity of displacement of elk winter concentration areas		Least quantity of displacement of elk winter concentration areas
			Concentrations	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
							> 27 acres	< 27 acres
		Range	Big Horn Sheep			Moderate quantity of displacement of designated summer range		Least quantity of displacement of designated summer range
Wildlife			Summer Range	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
whame	Alternatives		Big Horn Sheep Lambing Area	> 360 acres Greatest quantity of displacement of designated lambing range	271 to 360 acres	181 to 270 acres Moderate quantity of displacement of designated lambing range	90 to 180 acres	< 90 acres Least quantity of displacement of designated lambing range
	Alter			Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
	FGT /			~ ,	~ ~		> 1 acre	<1 acre
		Piologiaal		Greatest quantity of CNHP-designated biological diversity area intersected.		Intermediate quantity of CNHP-designated biological diversity area intersected.		Least quantity of CNHP-designated biological diversity area intersected.
		Diological	Diversity	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		ļ		> 110 acres	82-109 acres	55-81 acres	27-54 acres	< 27 acres
				Greatest additional linear miles of structural barrier intersecting designated wildlife crossings areas.		Intermediate additional linear miles of structural barrier intersecting designated wildlife crossings areas.		Least additional linear miles of structural barrier intersecting designated
		Crossings		5 5 5	Provensi (in the second s	5 5	<i>R</i>	wildlife crossings areas.
				Resource Quantifications > 37 miles	Resource Quantifications 28-36 miles	Resource Quantifications 19-27 miles	Resource Quantifications 9-18 miles	Resource Quantifications <9 miles
				Greatest additional linear miles of structural barrier	20-50 miles	Intermediate additional linear miles of structural barrier intersecting	3-10 111103	Least additional linear miles of structural barrier intersecting potential
				intersecting potential lynx crossings		potential lynx crossings		lynx crossings
		Lynx Hab	oitat	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
				> 8 miles of lynx crossing	6-8 miles of lynx crossing	4-6 miles of lynx crossing	2-4 miles of lynx crossing	< 2 miles of lynx crossing
		Boreal To	oad Habitat	Greatest loss of boreal toad breeding habitat.		Intermediate encroachment upon boreal toad breeding habitat.		Least encroachment upon boreal toad breeding habitat.
T&E Species		Dorear TC		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
				< 82 feet to toad breeding habitat	82-164 feet to toad breeding habitat	165-246 feet to toad breeding habitat	247-328 feet to toad breeding habitat	> 328 feet to toad breeding habitat
			and Greenback	Disruption of streams with Colorado and Greenback Cutthroat Trout.				No disruption of streams with Colorado and Greenback Cutthroat Trout.
		Cutthroat	Irout	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications

RESOURCES	CONFLICT CRITERIA ¹	ASSUMPTIONS	APPLICABLE FEDERAL, STATE REGULATIONS ²	Ī
Land Use / Recreation	Potential for encroachment, disruption, or fragmentation of communities and recreation use areas.	 Land use inventories are based on 2000 aerial photography, and published sources that identify existing recreation uses. Future land use planning by Federal, State, and Local jurisdictions is currently under review and will be addressed in the Draft PEIS. 	Section 6(f) of the Land and Water Conservation Fund Act. Section 4(f) of the Transportation Act of 1966.	Ī
	Potential for conflict is based on most restrictive USFS visual and recreation management prescriptions, and foreground and middleground views from sensitive receptors.	 Communities, historic, and recreation sites are considered to be most sensitive to visual changes. The appearance of features in the landscape varies with the viewing distance and project type. The lands seen from existing viewers in the study area were divided into three distance zones: foreground - from 0 to ½ mile, middleground - ½ to 4 miles, background – beyond 4 miles. The visual screening focuses on changes to local viewsheds within foreground distance zones. The visual screening focuses on the most restrictive visual management prescriptions on Forest Service lands, including Retention VQO, and High and Very High Scenic Integrity. 	USFS Management Visual and Recreation Management Prescriptions.	
Cultural Resources (Historic and Archaeological)	Potential for conflict is based on disturbance of significant cultural resources including National Historic Landmarks and/or Historic Districts and sites listed on, or eligible for, the National Historic Register.	 Screening was conducted to determine Historic Districts, Landmarks and properties crossed, as well as those within 300 feet of either side of each alternative. This 300 foot buffer zone was included to identify the potential for impacting the setting and feeling of properties, which are National Historic Register criteria. 	Section 106 of Historic Preservation Act, FHWA Section 4(f).	
Noise	Potential for conflict is based on the increases in peak-hour in Leq noise level, 24-hour noise level, and number of receptors impacted, as well as potential for noise mitigation.	 Regulatory agencies (CDOT and FHWA) and communities in the corridor are target audiences for the noise analysis. CDOT/FHWA regulate highway noise based on the peak-hour noise level. It is assumed that the peak-hour comparison would address all of the citizen's issues. Most of the alternatives will be very similar during the peak-hour but may exhibit more significant differences in 24-hour noise levels. Also, looking forward to the PEIS when alternatives will have both rail and highway elements, FTA regulates noise on a 24-hour basis. The number of receptors impacted (i.e. within the 66 dBA contour) provides regulators with a metric to judge the impact of an alternative Corridor wide. The potential for mitigation is very important because one alternative may be louder than the other with no mitigation but be quieter with mitigation. For example, a bypass route and a non-bypass route through Clear Creek County would have the same noise levels at 200 feet but obviously would produce much different levels in town. 	FHWA, FTA, and FRA regulate highway, light rail, and heavy rail noise, respectively. The policies of these agencies mandate that noise impacts be mitigated when feasible. FHWA defines noise impact as noise levels exceeding standards (e.g., 66 dBA for residences) and when design-year noise levels exceed existing levels by 10 dBA or more. FTA and FRA impact criteria define impact standards based on existing noise levels.	
Environmental Justice	Potential for conflict is based on disproportionate effects to low income and minority populations.	1. Criteria for low income based on EPA and FHWA criteria.	Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low- Income Populations."	

¹ In order to distinguish between alternatives, potential levels of conflict range from greatest to least based on these criteria

² This column is not intended to provide a comprehensive listing of laws, ordinances, regulations, or standards, rather it highlights key regulatory factors that are considered instrumental considerations in the Level 2 Screening process

MIS & RELATED ISSUES FROM PUBLIC SCOPING & AGENCY	COMMENTS
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Identified in the Clear Creek County Survey, EPA, & NPS.

Identified in the Clear Creek County Survey and the MIS - The amount of rock cuts and retaining wall needed for the TSM build elements will need to be addressed, as will the visual impact of the FGT guideway. (ES-11) Identified by the USFS.

Identified in the Clear Creek County Survey and the MIS - The vision will pass through an historic district in Idaho Springs and an historic landmark district in Georgetown and Silver Plume. This will complicate approvals for construction through these areas. (ES-11) Identified by SIPO.

Identified in the Clear Creek County Survey and the MIS - Approximately 2,600 dwellings are located within 500 feet of 1-70, and noise impacts are a concern. After a transit technology is defined, an evaluation and mitigation of noise impacts will be required. (ES-11) Identified by EPA.

Identified in the Clear Creek County Survey and by EPA

RESOURCES Graphic Legend		Greatest Potential for Conflict / Critical Environmental & Hazard Issues	Range between Greatest to Intermediate Intermediate Potential for Conflict Potential for Conflict Intermediate Potential for Conflict		Range between Intermediate to Least Potential for Conflict	Least Potential for Conflict
	Communities	Disruption of or fragmentation of a community		Proximity to community or development		No community encroachment
Land Use / Recreation		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
Land Ose / Kerreation		> 5 miles		1 to 5 miles		< 1 mile
	Recreation 4(f)/6(f) Properties	Disturbance known of 4(f) / 6(f) property (see viewshed analysis below)		Proximity to known 4(f)/6(f) properties (see viewshed analysis below)		No 4(f)/6(f)\ encroachment (see viewshed analysis below)
	Scenery Management	Most restrictive USFS Visual and Recreation management prescriptions.		Moderate restrictive USFS Visual and Recreation management prescriptions.		Least restrictive USFS Visual and Recreation management prescriptions.
	Community Viewsheds	Elevated structures within foreground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.		Highway widening within foreground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.		Highway widening within middleground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.
Federal Management		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
and Scenic Features / Views		> 5 miles		1 to 5 miles		< 1 mile
v iews	Recreation Site Viewsheds	Elevated structures within foreground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.		Highway widening within foreground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.		Highway widening within middleground views from communities, recreation sites and historic landmarks, districts and sites listed or eligible for the NRHP.
		Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		> 5 miles		1 to 5 miles		< 1 mile
Cultural Resources		Cross national historic district or landmark, or crosses many historic sites		Adjacent to national historic district or landmark, or crosses several historic sites		No known historic landmarks, districts, or sites are crossed or are in the immediate vicinity
(Historic and Archaeolog	gical)	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications	Resource Quantifications
		5 to 10 historic site crossed or a historic district is encountered		1 to 4 historic site crossed or alternative is adjacent to a historic district		No identified historic sites crossed, no historic districts or landmarks encountered or adiacent
Noise		Much greater than the existing number of receptors impacted / a 24 hour noise increase of 10 dB of more, and a peak-hour noise increase of 10 dB or more	Greater than existing number of receptors impacted / a 24 hour increase of 7-9 dB and a peak hour level increase of 7-9 dB	Same as existing number of receptors impacted / a 24 hour noise increase of 5 to 7 dB and a peak-hour noise increase of 5 to 7 dB	Fewer than existing number of receptors impacted / a 24 hour increase of 3-4 dB and a peak-hour increase of 3-4 dB	Far fewer than existing number of receptors impacted / a 24 hour noise increase of 0 to 2 dB, and a peak-hour noise increase of 0 to 2 dB
Environmental Justice			Low-income and r	ninority populations will generally be identified and a public outreac	h program will be conducted	

ENVIRONMENTAL SENSITIVTY	NAME	FIRM	HIGHEST DEGREE AND YEARS OF EXPERIEINCE
Air Quality (Support from Jim DeLio – Colorado department of Public Health and Environment and Jeff Houck – EPA)	Amy Baerenklau	JFSA	M.S. in Environmental Science, 4 years
Water Quality	Mike Crouse	Clear Creek Consultants	B.S. in Aquatics Biology, 17 years
Wetlands	Dr. Loren Hettinger Pat Murphy	JFSA Ecotone	Ph.D., Plant Ecology, 22 years M.A. in Vegetation Ecology, 22 years
Wildlife Habitats and Crossings Threatened, Endangered and Sensitive Species	Robert Henke	SAIC	B.S. Forestry, Fisheries & Wildlife Management M.S. Wildlife Biology, 19 years
Fish Habitats	Bob Quinlan	JFSA	B.S. in Aquatic Biology, 20 years
Geologic Hazards/Mining	Rick Andrews	Yeh & Associates	M.S. in Geology, 17 years
COMMUNITY VALUES			
Noise	Mike Hankard	Hankard Environmental	B.S. Electric Engineering with Acoustic Specialty, 11 years
Land Use/Recreation/4(f)/6(f) Federal Management and Scenic Features/Views	Tim Tetherow Teresa O'Neil	JFSA	M.S. in Landscape Architecture, 28 years B.S. in Landscape Architecture, 10 years
Cultural Resources	Dr. Steve Mehls	Western Historical Studies	Ph.D. in History of U.S. Western Movement, 22 years

	ROLE IN LEVEL 2 ANALYSIS
	Coordinated studies with the Colorado Department of Environmental Health and the Environmental Protection Agency
	Conducted water quality analysis
	Conducted wetland analysis
	Conducted wildlife habitats and crossings analysis
	Conducted fish habitat assessment
	Conducted geologic hazards and mining analysis
11	Conducted noise analysis
	Conducted land use/recreation/4(f)/6(f) analysis
ears	Conducted cultural resources analysis

Environmental and Community Values Analysis

Step 1) Identify Issues

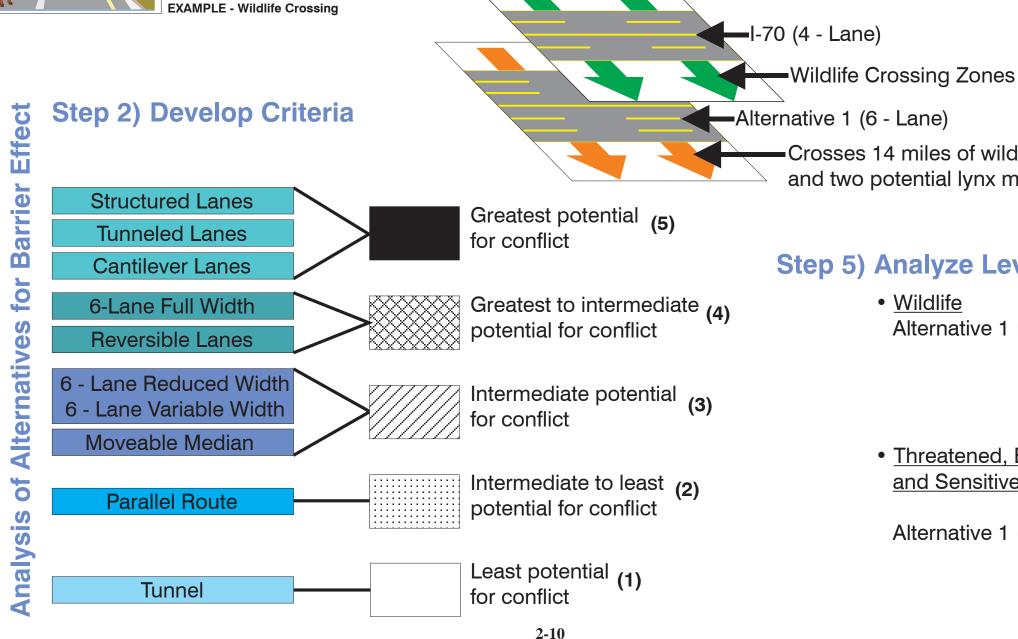
- Scoping
- I-70 MIS
- Agency Consultation
- TAC/MCAC
- Best Professional Judgement

Step 3) Conduct GIS Overlay Analysis

- General Wildlife Movement Corridors
- Elk and Deer Crossings
- Potential Lynx Movement Corridor
- Increased Barrier Effect from Alternatives

Roadway Alternatives

Step 4) Quantify Potential for Conflict

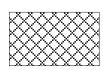


Crosses 14 miles of wildlife crossing area

and two potential lynx movement corridors

Step 5) Analyze Level of Conflict

Alternative 1 =



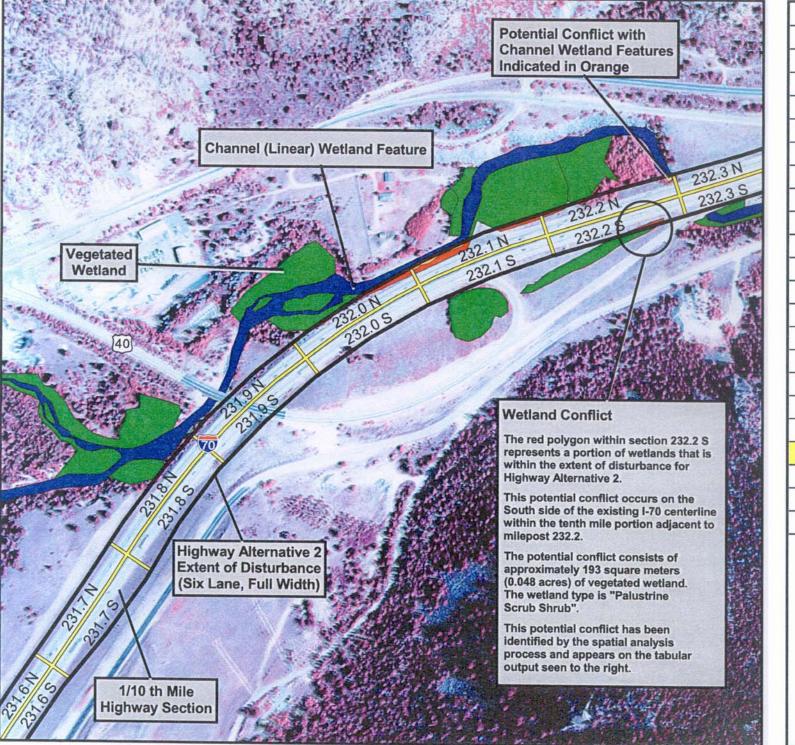
• Threatened, Endangered, and Sensitive Species

Alternative 1 =



I-70 / U.S. 40 Interchange Area

Color Infrared Aerial Imagery, General Wetlands Mapping and Potential Wetland Conflicts



Tabular Data Output From Spatial Analysis Process

SECTION	CLASS	<u>TYPE</u>	AREA (square meters)	ACRES
231.6 N			0.000	0.000
231.6 S			0.000	0.000
231.7 N			0.000	0.000
231.7 S			0.000	0.000
231.8 N	PSS	Wet Veg	5.131	0.001
231.8 N			0.000	0.000
231.8 S			0.000	0.000
231.9 N			0.000	0.000
231.9 S			0.000	0.000
232 N	PFO	Wet Veg	551.207	0.136
232 N			0.000	0.000
232 S			0.000	0.000
232.1 N	PFO	Wet Veg	780.096	0.193
232.1 N			0.000	0.000
232.1 S			0.000	0.000
232.2 N	PFO	Wet Veg	117.385	0.029
232.2 N	PSS	Wet Veg	42.138	0.010
232.2 N			0.000	0.000
232.2 S	PSS ,	Wet Veg	193.180	0.048
232.2 S			0.000	0.000
232.3 N			0.000	0.000
232.3 S			0.000	0.000
the Palustrine Scr	abular output repres ub Shrub feature in flict in the figure to	dicated	KEY PSS - Palus	strine Scrub Sh

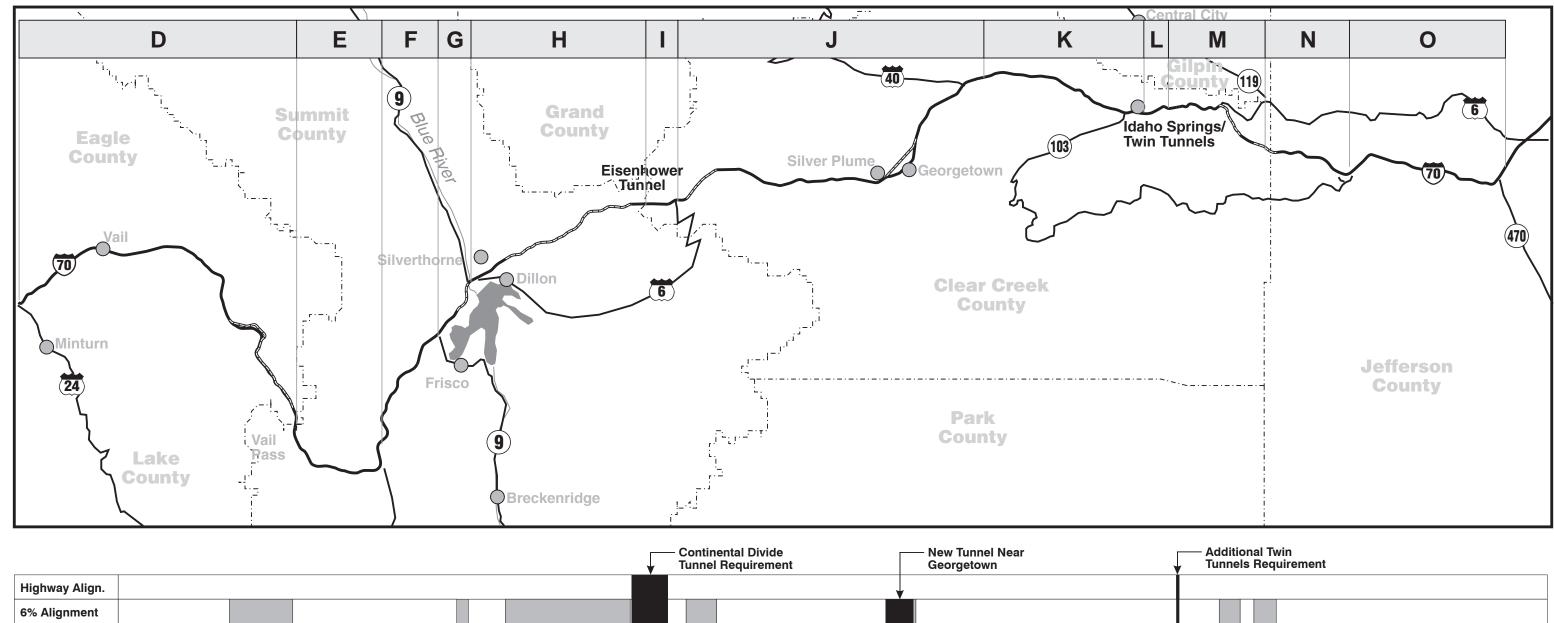
DRAFT 03/20/20

Wet Veg - Vegetated Wetlands

	Disturbance Area Assumptions For and Rubber Tire T			
	Roadway Template Width (feet)	Variable Construction Width (feet)	Construction Disturbance Buffer (feet)	Potential Total Area of Disturbance
Highway Alternatives				
6-lanes/ Full Width Barrier Separated	122'	30' max on either side	15' max on either side	167'
6-lanes/ Full width Open Median	148'	30' max on either side	15' max on either side	193'
6-lanes/ Reduced Width	98'	30' max on either side	15' max on either side	143'
Flex Lanes	90'	30' max on either side	15' max on either side	135'
Parallel Route	44'	15' max on either side	15' max on either side	89'
Structured Lanes Full Width	60'	30' max on either side	15' max on either side	105'
Structured Lanes Reduced Width	48'	30' max on either side	15' max on either side	93'
Tunneled Lanes	48'	30' max on either side	15' max on either side	93'
Cantilever Wall	96'	30' max on either side	15' max on either side	141'
Moveable Lanes	90'	30' max on either side	15' max on either side	135'
Reversible Lanes	116'	30' max on either side	15' max on either side	161'
Fixed Guideway Transit Alternatives				
Highway Alignment Alternatives along I-70	60' beyond edge of pavement of I-70 (30' / up to 30' for construction)	_	_	60'
6% Grade Alignment:				
On I-70 Grade (up to 6 %)	60' beyond edge of pavement of I-70	_	_	60'
Grade Reduction Area (over 6 %)	120' beyond edge of pavement of I-70	-	-	120'
CIFGA Monorail Alternative	60' beyond edge of pavement where on north side of I-70 45' beyond edge of pavement where on south side of I-70	_	_	60' where on north side 45' where on south side
Rubber Tire Transit Alternatives				
HOV	122' (same as 6-lane full highway alternative)	30' max on either side	15' max on either side	167'
Guideway (C-470 to Eisenhower Tunnel)	98' (same as 6-lane reduced highway alternative)	30' max on either side	15' max on either side	143'
Transitway (C-470 to Vail)	60' beyond edge of pavement of I-70	_	_	60'
Bus in Mixed Traffic	No Change from Existing Roadway Template	_	_	_

* Existing I-70 width between C470 and Vail ranges from approximately 78' to 175' width median

3 - FGT ALTERNATIVES





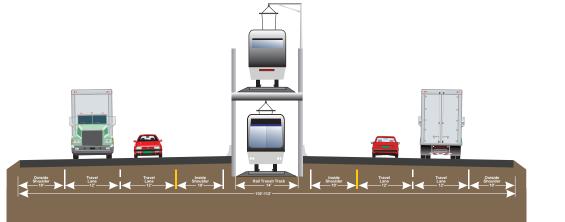
*4% Alignment

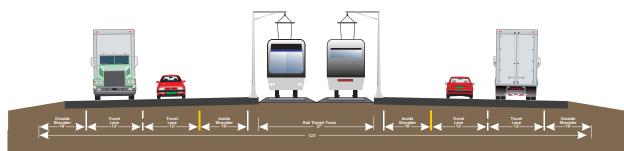


Additional Twin Tunnels Requirement													

I-70 Mountain Corridor PEIS **Fixed Guideway Transit Alternatives**

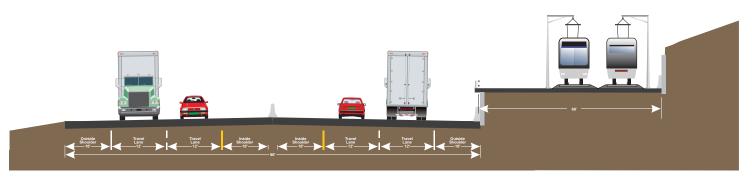
03/20/01



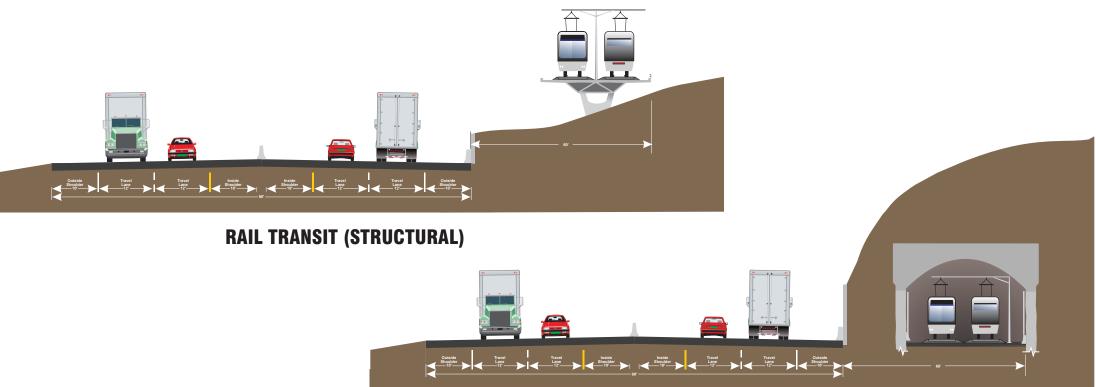


RAIL TRANSIT (WIDE MEDIAN)

RAIL TRANSIT (TIGHT MEDIAN)



RAIL TRANSIT (BENCH)

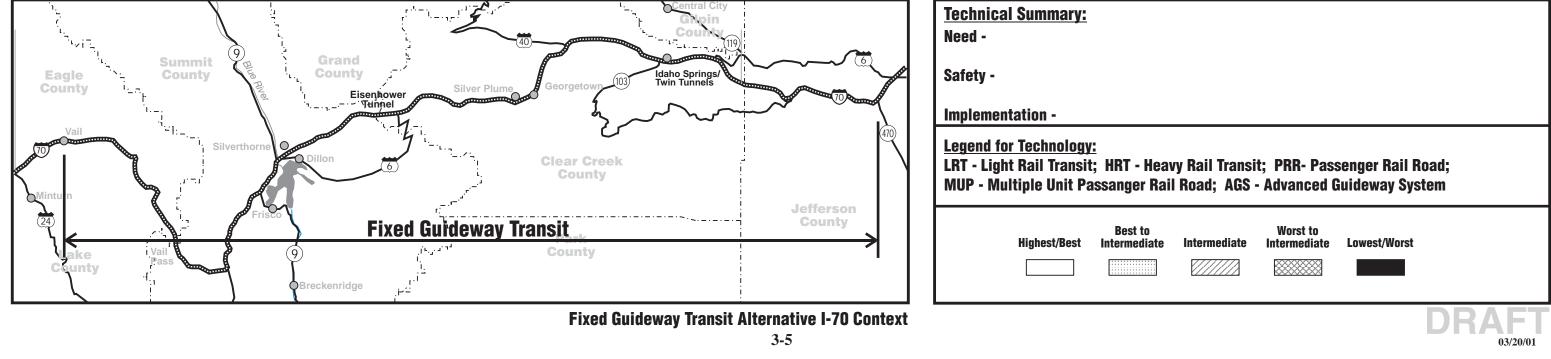


RAIL TRANSIT (TUNNEL)

Fixed Guideway Transit Alternatives 3-4



Fixed Guideway					Ne	ed			Safety		Implem	entation		
Transit Alternat	System Capacity (Peak Hour)		System Attractiveness		rage eed	Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fuel		Energy Consumption	
Highway Alignment		Actual	Rating		Actual	Rating						Avail.	Limit	
Diesel Power		4												
Technology	Track													
LRT	Single	1416			46.1									
LRT	Double	2832			46.1									
PRR - Winter Park	Single	1400			23.2									
PRR - Glenwood Springs	Single	1400			28.7									



Please Refer to Energy Requirements Mineralized Rock Vegetated Wetlands Gold Medal Fisheries Elk Winter Concentration Winter Maintenance Fen/Seep/Spring Mineralized Rock Big Horn Sheep Range Image: Concentration Big Horn Sheep Range Image: Concentration Image: Concentration Image: Concentration Image: Concentration				Environmental Sensitivity				
Please Refer to Energy Requirements Winter Maintenance Fen/Seep/Spring Gold Medal Fisheries Big Horn Sheep Range IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats				
		Mineralized Rock Winter Maintenance	Vegetated Wetlands Fen/Seep/Spring	Gold Medal Fisheries	Under Study Elk Winter Concentration Big Horn Sheep Range Big Horn Sheep Lambing Area Biodiversity Area			
		Summary		Summary	-			



Wetlands

· Wildlife Habitats and Crossings

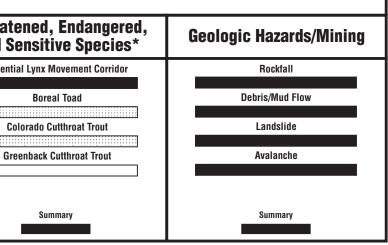
Threatened, Endangered & Sensitive Species

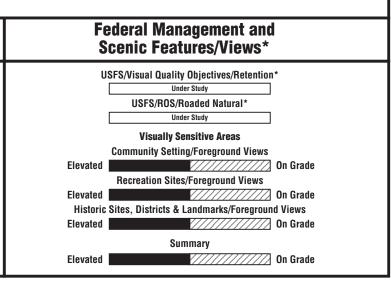
· Fish Habitats

· Geologic Hazards/Mining

	Communi	ty Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Noise Increase	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

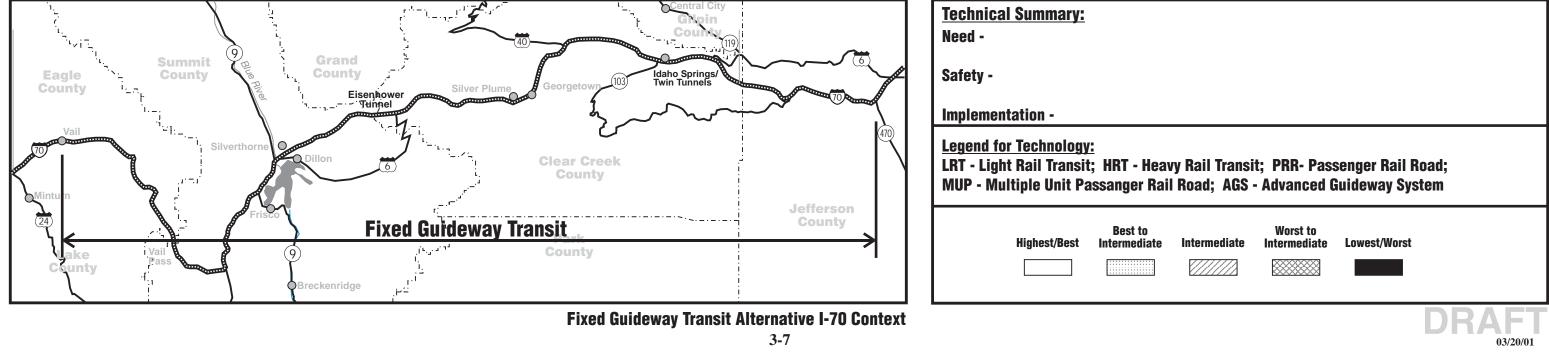






Fixed Guideway Transit AlternativeHighway AlignmentDRAFTDraftOrderOver

Fixed Guideway	1				Ne	ed			Safety		Implem	entation		
Transit Alternat	System Capacity (Peak Hour)		System Attractiveness	-	rage eed	Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fuel		Energy Consumption	
Highway Alignment		Actual	Rating		Actual	Rating						Avail.	Limit	
Electric Power														
Technology	Track	1												
LRT	Single	1320			48.6									
LRT	Double	2640			48.6									
AGS - Supported	Double	4200			63									
AGS - Suspended	Double	4200			63									
AGS - Side Hanging	Unit	4200			63									

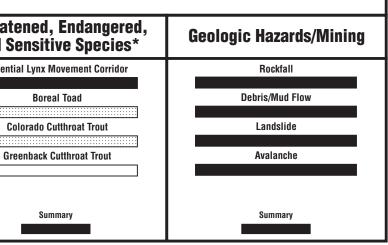


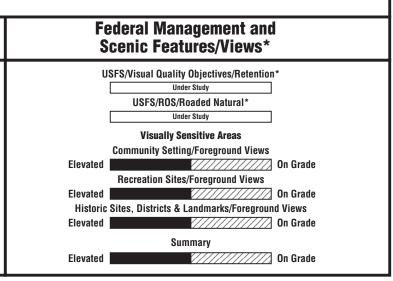
			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Please Refer to Energy Requirements	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Deer Range Under Study Elk Winter Concentration Big Horn Sheep Range Elk Winter Concentration Big Horn Sheep Lambing Area Big Horn Sheep Lambing Area General Wildlife Crossing	Pote
	Summary	Summary	Summary	Summary	
					_



	Community V	alues	
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*	
Noise Increase	Community Areas	Historic Districts	J
	Recreation (4(f)/6(f))	Historic Sites & Trails	
	Hike and Bike Trails	Archaeological Sites	
Summary	Summary	Summary	

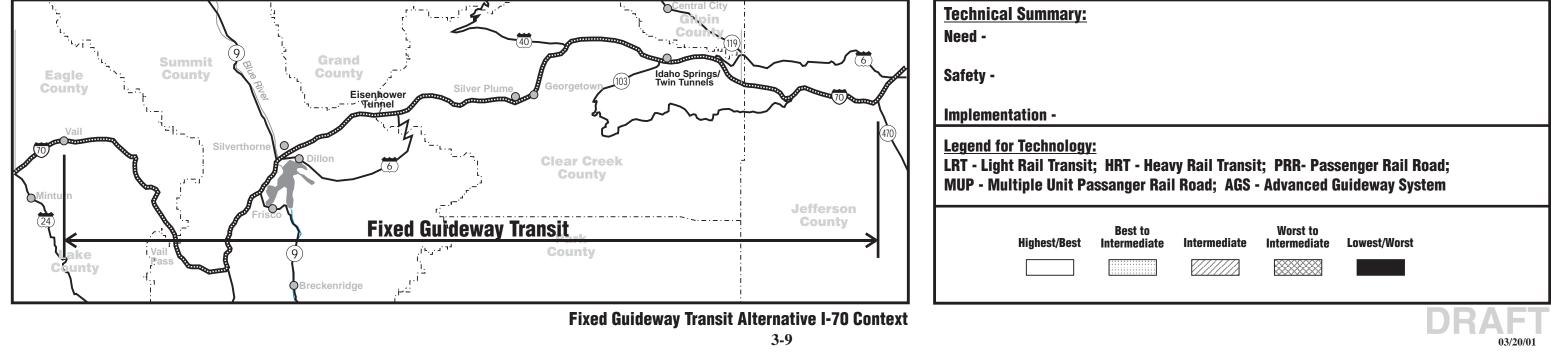
Summar	y - Commun	ity Values				· Federal Management and Sc	enic Features/Views
· Noise							
· Land Use/R	ecreation/4(f) and 6(f)					
· Cultural Res	sources/4(f)						
Legend							
Level of (Conflict				* Applicable Federal Regulations		Fixed Quide
Greatest	Greatest - Intermediate	Intermediate	Intermediate - Least	Least	(Refer to Table x)		Fixed Guide
Potential for Conflict	Potential for Conflict	Potential for Conflict	Potential for Conflict	Potential for Conflict			
						3-8	DRAFT
						3-0	





eway Transit Alternative Highway Alignment Electric Power

Fixed Guideway					Ne	ed			Safety		Implem	entation		
Transit Alternative			tem acity (Hour)	System Attractiveness	Average Speed		Connectivity	Feeder/Distribution Requirements	System Safety	Costs Technology Available				Energy Consumption
6% Alignment		Actual	Rating		Actual	Rating						Avail.	Limit	
Diesel Power														
Technology	Track]												
LRT	Single	1416			45.8									
LRT	Double	2832			45.8									
HRT	Single	4320			33.3									
HRT	Double	8640			33.3									
PRR in Corridor	Single													
PRR in Corridor	Double													



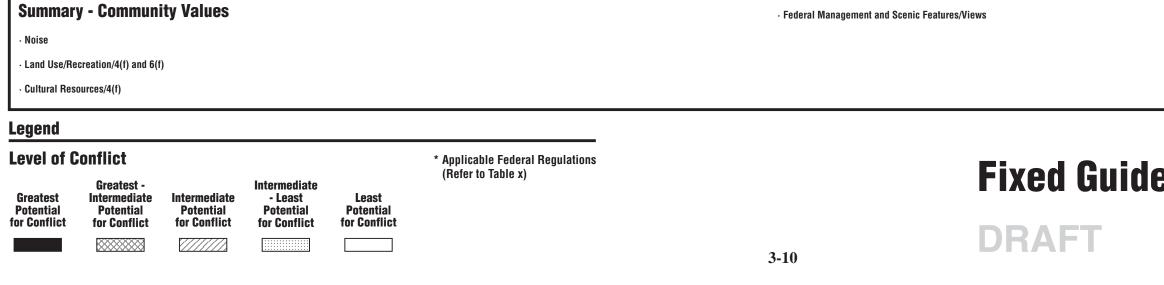
			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Please Refer to Energy Requirements	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Deer Range Under Study Elk Winter Concentration Big Horn Sheep Range Several Big Horn Sheep Lambing Area Big Horn Sheep Lambing Area Biodiversity Area General Wildlife Crossing	Pote
	Summary	Summary	Summary	Summary	
Summary - Environmental Sen	isitivity		 Wildlife Habitats and Cr Threatened, Endangered 	-	
Water Quality			· Fish Habitats		

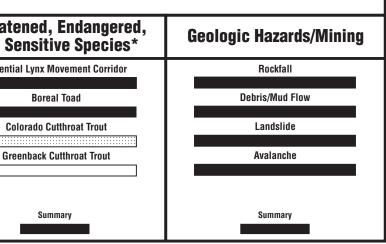
Wetlands

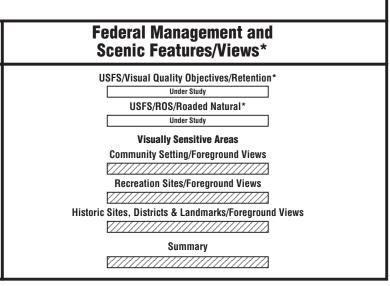
Fish Habitats

· Geologic Hazards/Mining

	Communi	ty Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Noise Increase	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

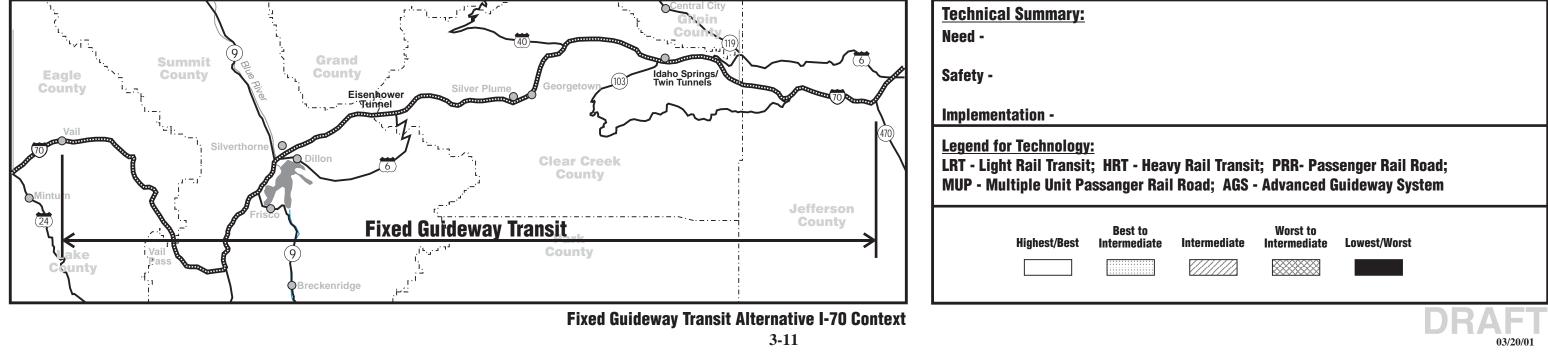






Fixed Guideway Transit Alternative 6% Alignment Diesel Power 03/20/01

Fixed Guideway					Ne	ed			Safety		Implem	entation		
Transit Alternative			tem acity (Hour)	System Attractiveness	Average Speed		Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fu	iel	Energy Consumption
6% Alignment		Actual	Rating		Actual	Rating						Avail.	Limit	
Electric Power														
Technology	Track	1												
LRT	Single	1320			48.4									
LRT	Double	2640			48.4									
HRT	Single	4200			44.6									
HRT	Double	4200			44.6									
PRR in Corridor	Single													
PRR in Corridor	Double													
AGS - Supported	Double	4200			64.5									
AGS - Suspended	Double	4200			64.5									
AGS - Side Hanging	Unit	4200			64.5									
MUP	Single	4380			42.8									
MUP	Double	8760			42.8									



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Please Refer to Energy Requirements	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Deer Range Under Study Elk Winter Concentration Big Horn Sheep Range Big Horn Sheep Lambing Area Biodiversity Area General Wildlife Crossing	Pote
Summary - Environmental Sei	summary nsitivity	Summary	Summary	Summary	
· Air Quality			\cdot Threatened, Endangered	& Sensitive Species	

Fish Habitats

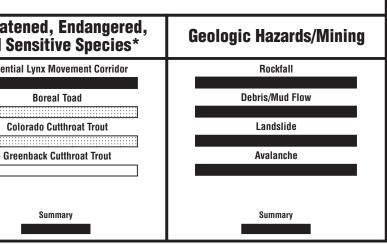
· Geologic Hazards/Mining

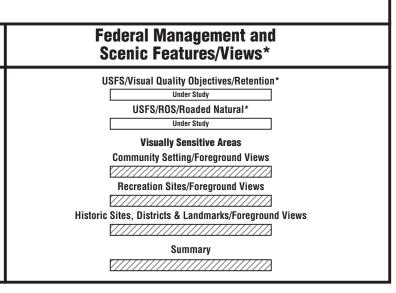
· Water Quality

 \cdot Wetlands

	Communi	ty Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Noise Increase	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

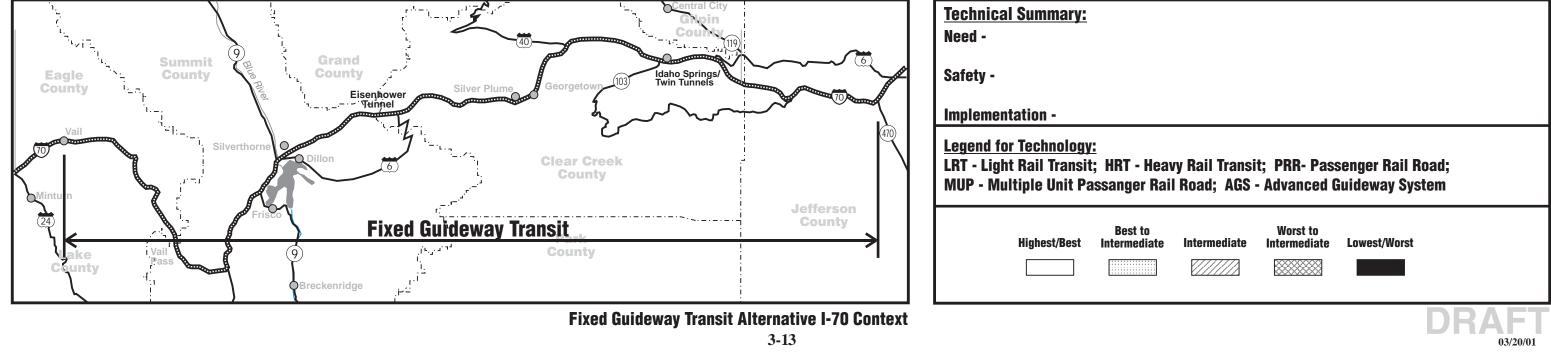
Su	mmary	/ - Commun i	ty Values					· Federal Management and Scenic Feature	s/Views
• Noi • Lan		creation/4(f) and 6(f)						
· Cul	iltural Resc	urces/4(f)							
Lege	end								
Leve	el of C	onflict				* Applicable Federal Regulations (Refer to Table x)			Fixed Guide
Grea Pote for Co	ential	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict	(FIXEU UUIUG
							3	-12	DRAFT



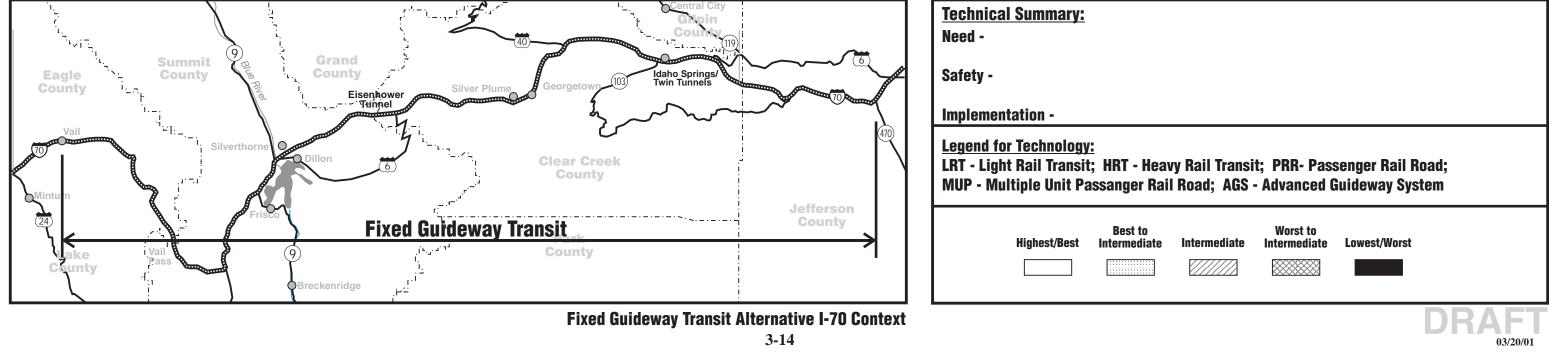


eway Transit Alternative 6% Alignment Electric Power

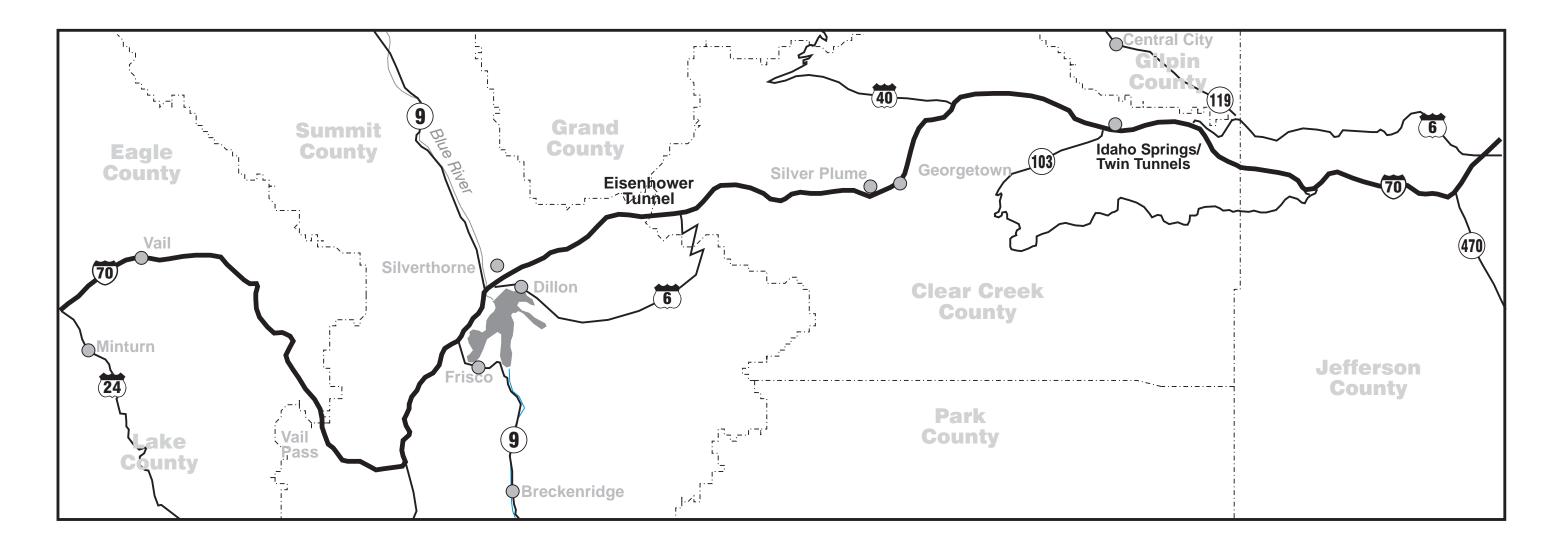
Fixed Guideway					Ne	ed			Safety	Implementation				
Transit Alternative			System Sys Capacity Attrac (Peak Hour)		Average s Speed		Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fuel		Energy Consumption
4% Alignment		Actual	Rating		Actual	Rating						Avail.	Limit	
Diesel Power														
Technology	Track]												
LRT	Single	1416			48.7									
LRT	Double	2832			48.7									
HRT	Single	4320			36.4									
HRT	Double	8640			36.4									
PRR in Corridor	Single													
PRR in Corridor	Double													



Fixed Guideway Transit Alternative					Ne	ed			Safety	Implementation						
		Cap	tem acity (Hour)	ity Attractiveness		rage eed	Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fu	iel	Energy Consumption		
4% Alignment		Actual	Rating		Actual	Rating						Avail.	Limit			
Electric Power																
Technology	Track	1														
LRT	Single	1320			50.2											
LRT	Double	2640			50.2											
HRT	Single	4200			47.2											
HRT	Double	4200			47.2											
PRR in Corridor	Single															
PRR in Corridor	Double															
AGS - Supported	Double	4200			68.3											
AGS - Suspended	Double	4200			68.3											
AGS - Side Hanging	Unit	4200			68.3											
MUP	Single	4380			45.7											
MUP	Double	8760			45.7											

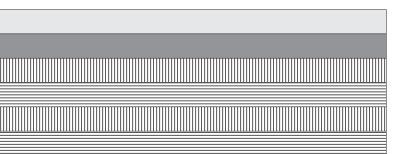


4 - RTT ALTERNATIVES



Bus/Van in Mixed Traffic or HOV Lanes (Diesel Only)	
or HOV Lanes (Dieser Only)	
Transitway	
Guideway	

LEGEND
Bus/Van in Mixed Traffic or HOV Lanes (Diesel Only)
Mixed Traffic
All HOV Options
Diesel and Dual Power Options
Electric Power Option



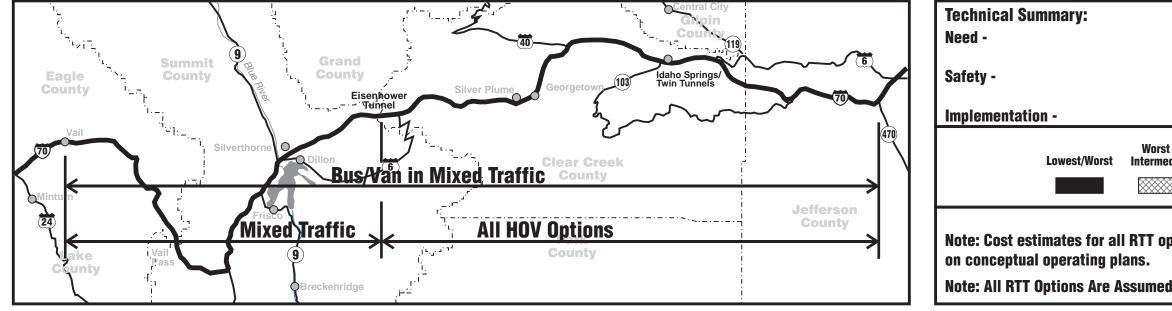
I-70 Mountain Corridor PEIS Rubber Tire Transit Alternatives

03/20/01

4-4

RTT Sections To Be Provided

Rubber Tire Transit Alternative		Practical System Capacity Attractiveness (Peak Hour)		Need Average Speed		Connectivity	Feeder/Distribution Requirements	Safety System Safety	Costs
Bus/Van in Mixed Traff HOV Lanes (Diesel Only	ic or /)	Rating		Actual MPH Ratin					CAP.
Type of HOV	Direction								
Bus/Van in Mixed Traffic	Both			36					
Marked Lane	Peak			51					
Marked Lane	Both			51					
Separated Lane	Peak			51					
Separated Lane	Both			51					



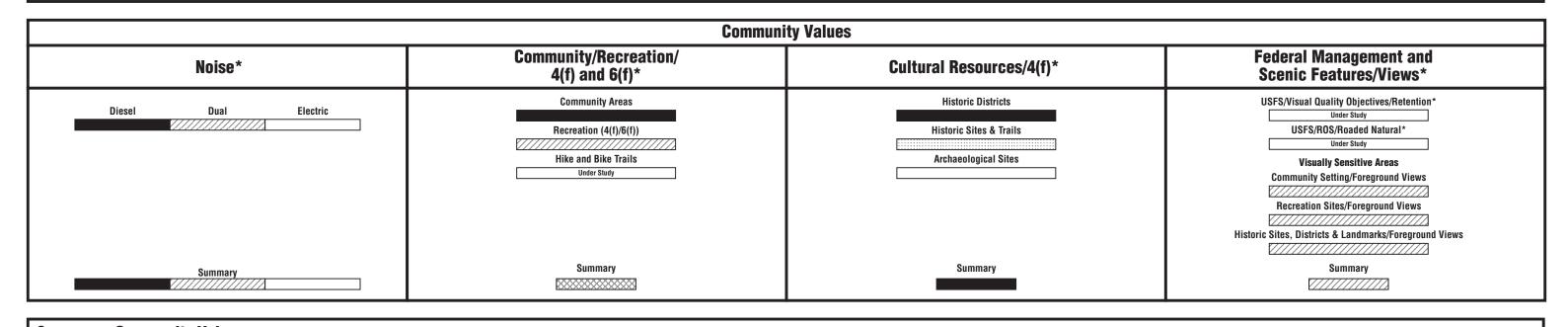
Rubber Tire Transit Alternative I-70 Context

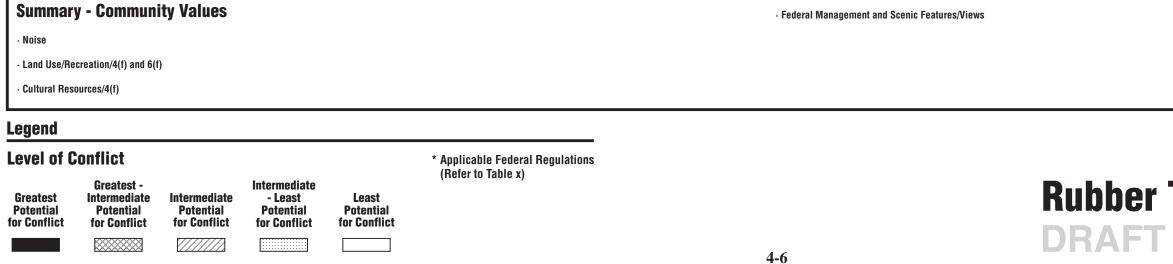
Implem	entation	
Technology Available	Fuel Usage	Energy Consumption

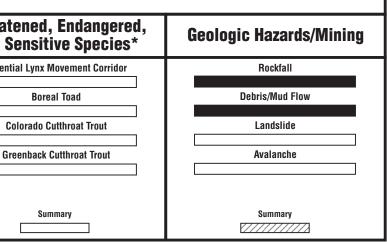
t to diate	Intermediate	Best to Intermediate	Highest/Best				
otions were developed							
t to Operate in the Current Highway Alignment.							
			DRAF 03/20/	/01			

Air quaitty water quaitty waters of the U.S./wetlands FISH Habitats and Crossings and Mine Tailings/Waste Rock Open and Flowing Waters High Value Fishery Deer Range Please Refer to Energy Requirements Miner Maintenance Vegetated Wetlands Gold Medal Fisheries Big Horn Sheep Range Image: Constraint of the Constrating the Constraint of the Constraint of the Constraint				Environmental Sensitivity		
Please Refer to Energy Requirements Summary Summar	Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats		Threa and
		Mineralized Rock Winter Maintenance Stormwater Runoff	Vegetated Wetlands Fen/Seep/Spring	Gold Medal Fisheries	Under Study Elk Winter Concentration Big Horn Sheep Range Big Horn Sheep Lambing Area Biodiversity Area General Wildlife Crossing Summary	



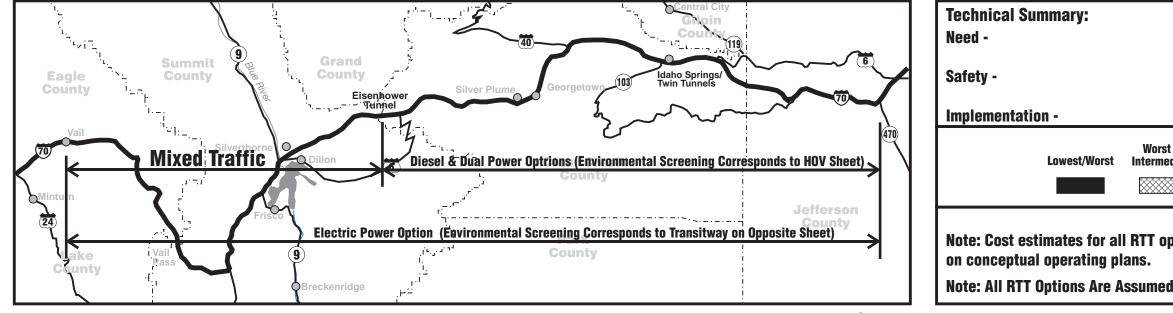






Rubber Tire Transit Alternative HOV Lanes 03/20/01

Rubber Tire Transit Alternative		Need						Safety	<u> </u>
		Practical Capacity (Peak Hour)	System Attractiveness	Ave	rage eed	Connectivity	Feeder/Distribution Requirements	-	Costs
Transitway		Rating	1	Actual MPH	Rating				CAP.
Type of Power	Direction								
Diesel Power									
	Peak			51					
	Both			51					
DualPower (Diesel/Elec)									
	Peak			60					
	Both			60					
Electric Power									
	Both			60					



Rubber Tire Transit Alternative I-70 Context

Implem	entation	
Technology Available	Fuel Usage	Energy Consumption

to diate	Intermediate	Best to Intermediate	Highest/Best				
\otimes							
ptions were developed							
I to Operate in the Current Highway Alignment.							
			DRAFT 03/20/01				

			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Please Refer to Energy Requirements	Mine Tailings/Waste Rock	Open and Flowing Waters Uegetated Wetlands Fen/Seep/Spring Summary	High Value Fishery Gold Medal Fisheries	Deer Range Under Study Elk Winter Concentration Big Horn Sheep Range Big Horn Sheep Lambing Area Biodiversity Area General Wildlife Crossing Summary	
Summary - Environmental S	ensitivity		· Wildlife Habitats and Cr	ossings	

· Threatened, Endangered & Sensitive Species

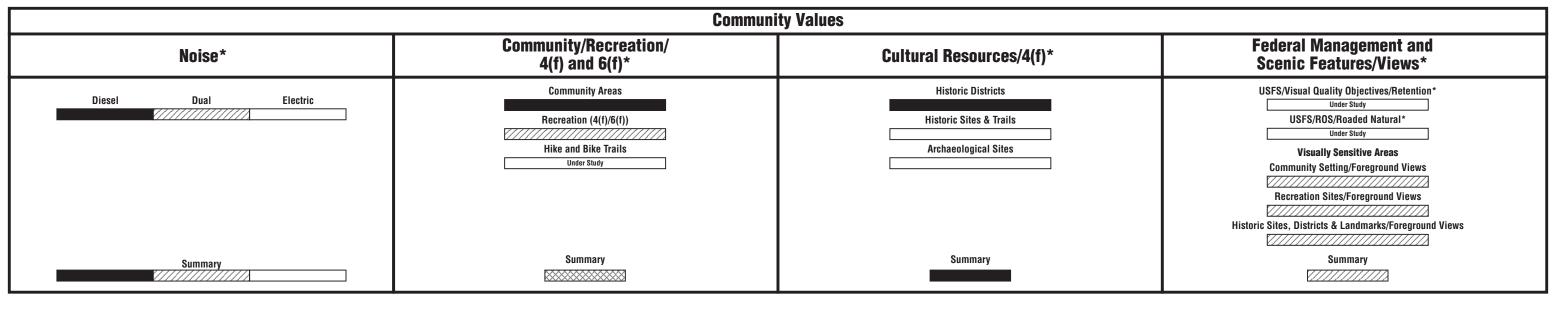
· Fish Habitats

· Geologic Hazards/Mining

Water Quality

Wetlands

· Air Quality



Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) Cultural Resources/4(f) Legend

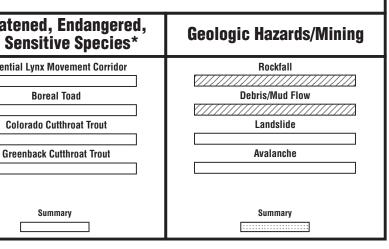
Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

* Applicable Federal Regulations (Refer to Table x)

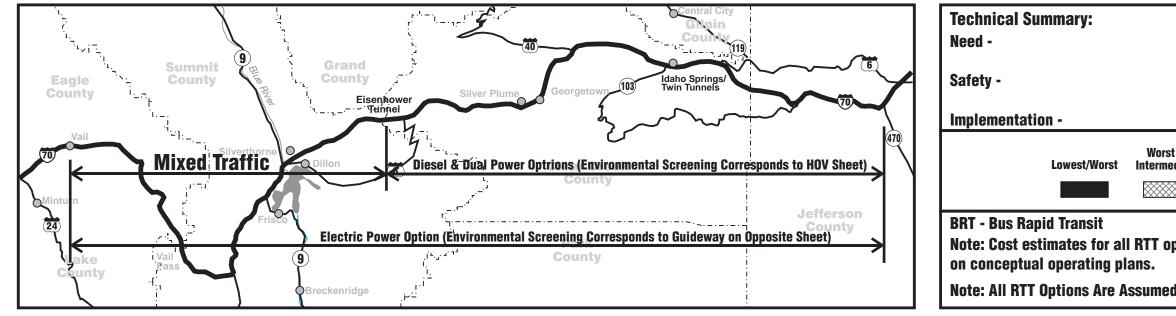


4-8



Rubber Tire Transit Alternative Transit Way 03/20/01

Rubber Tire		Need						Safety	1
Transit Alternative Guideway (Guided Transitway)		Practical System Capacity (Peak Hour)		Average Speed		Connectivity	Feeder/Distribution Requirements	System Safety	Costs
uliucway (uliucu Ital	1511way)	Rating	1	Actual MPH	Rating				CAP.
Type of Power	Direction								
Diesel Power									
	Peak			51					
	Both			51					
	BRT Station			54					
Dual Power (Diesel/Elec)									
	Peak			60					
	Both			60					
	BRT Station			64					
Electric Power									
	Both			60					
	BRT Station			64					



Rubber Tire Transit Alternative I-70 Context

Implem	entation	
Technology Available	Fuel Usage	Energy Consumption

t to diate	Intermediate	Best to Intermediate	Highest/Best	
-	s were develo	-	hway Alignmont	
a to U	perate in the	Gurrent Higi	hway Alignment. DRAF)/01

			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Please Refer to Energy Requirements	Mine Tailings/Waste Rock	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring Summary	High Value Fishery Gold Medal Fisheries	Deer Range Under Study Elk Winter Concentration Big Horn Sheep Range Summary Biodiversity Area Summary	
Summary - Environmental S	Sensitivity		· Wildlife Habitats and Cr	ossings	



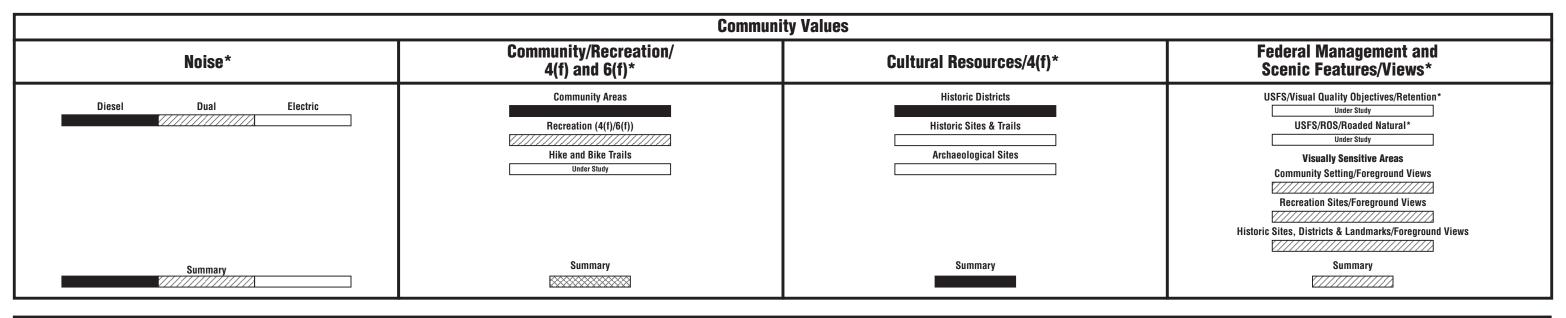
· Fish Habitats

· Geologic Hazards/Mining

Water Quality

Wetlands

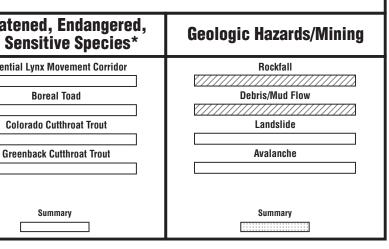
· Air Quality



Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) Cultural Resources/4(f) Legend **Level of Conflict** * Applicable Federal Regulations

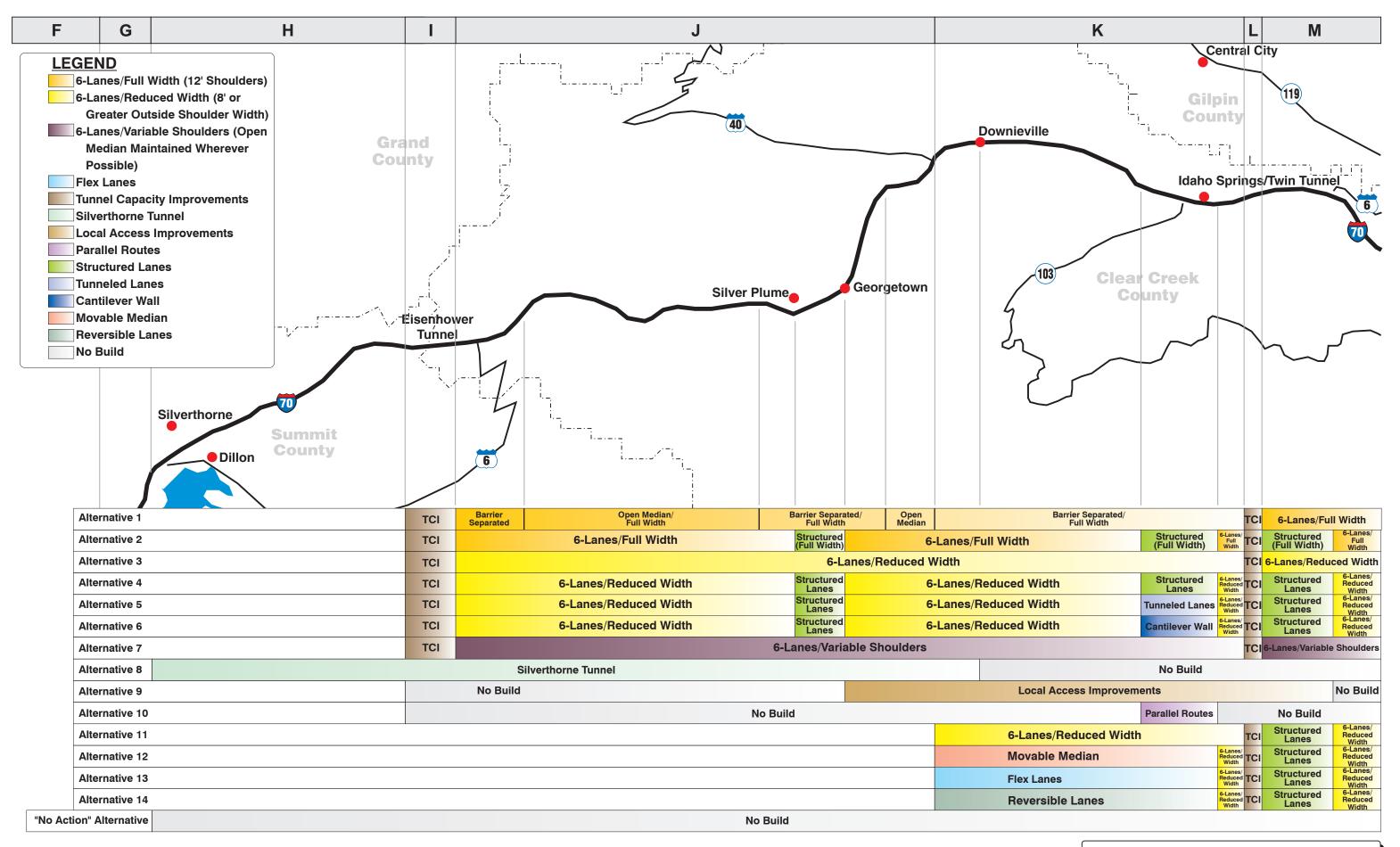


(Refer to Table x)



Rubber Tire Transit Alternative DRAFT Guideway 03/20/01

5 – HIGHWAY ALTERNATIVES



Note 1: Alternatives respond to 2020 conditions.

Note 2: Future alternatives may be a mix of various alternatives shown above.

I-70 Mountain Corridor PEIS Primary Highway Alternatives

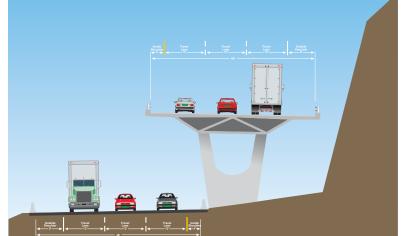
DRAFT

03/18/01

Highway Alternative Sections DRAFT

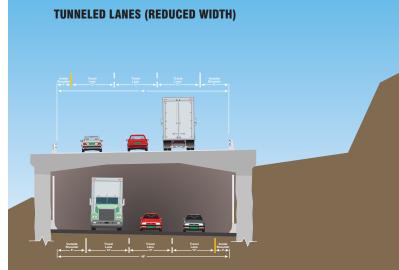


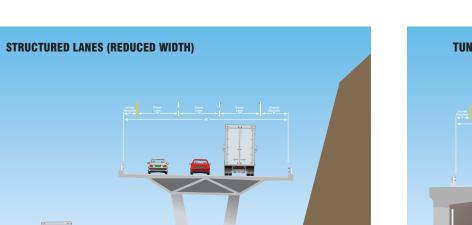
REVERSIBLE LANE (116')

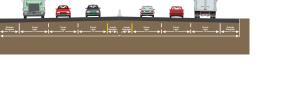


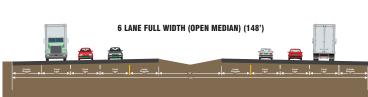
MOVEABLE MEDIAN (90') - OFF PEAK CONFIGURATION

MOVEABLE MEDIAN (90') - PEAK CONFIGURATION



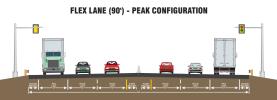


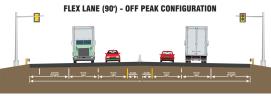




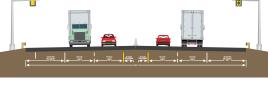
6 LANE REDUCED WIDTH (98')

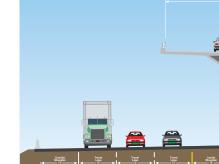




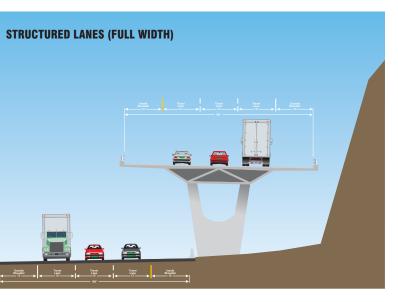








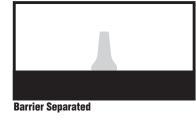
5-4



CANTILEVER WALL (REDUCED WIDTH)

03/20/01









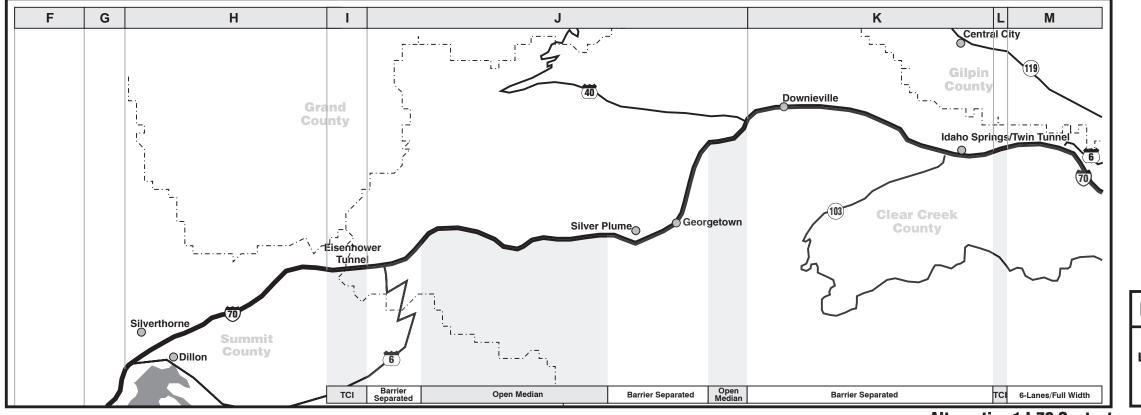
Open Median

Description of Highway Alternatives

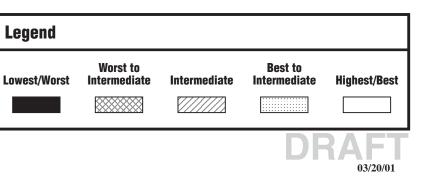
This Alternative is a hybrid of the various Full-width alternatives (open and barrier medians). The selection of median treatment was based on the available platform width where an existing barrier is present, a barrier section is proposed; where an open median is present, an open median is proposed.

			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Spe	eed	Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 1	0.56 LOS C	0.83 LOS D	65	61	0	0			<i>\</i>

Technical Summary:



Alternative 1 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	
	Summary	Summary	Summary	Summary	

· Threatened, Endangered & Sensitive Species

· Fish Habitats

· Geologic Hazards/Mining

Water Quality

Wetlands

· Air Quality

	Communi	ity Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail Z4-Hour Increase Idaho George- Springs Silver Vall Vail Vail Number of Receptors Idaho George- Springs Silver Number of Receptors Idaho George- town Silver Potential for Mitigation Idaho George- town Silver Potential for Mitigation Idaho George- town Silver	Community Areas Recreation (4(f)/6(f)) ///////////////////////////////////	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

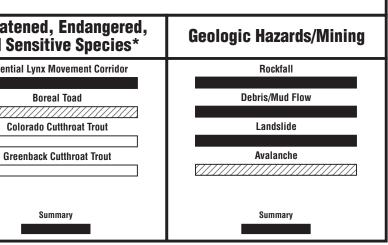
Summary - Community Values - Federal Management and Scenic Features/Views - Noise - Land Use/Recreation/4(f) and 6(f) - Cultural Resources/4(f) - Cultural Resources/4(f)

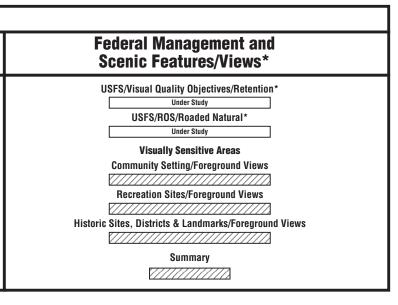
Legend

Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

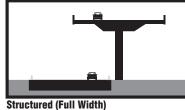












Description of Highway Alternatives

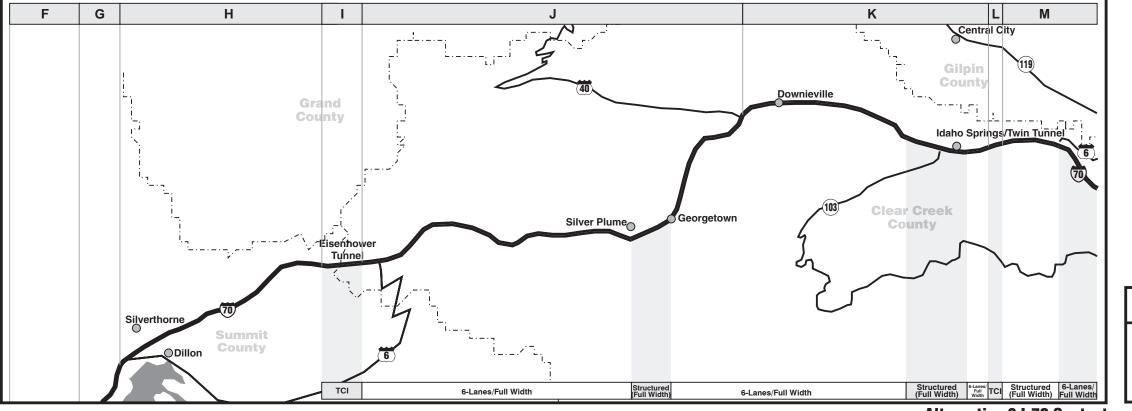
locations to minimize impacts.

This Alternative is a Full-width section. It is included as a baseline to which all other

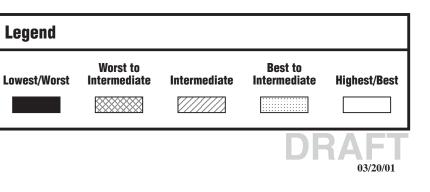
narrower sections will be compared. Structured Lanes are included in three sensitive

			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Speed			Duration of Congested Hours		Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 2	0.56 LOS C	0.83 LOS D	65	61	0	0			<i>\</i>

Technical Summary:



Alternative 2 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and S
Total Emissions Under Study % Change Between Alternatives and	Mine Tailings/Waste Rock Mineralized Rock	Open and Flowing Waters	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings	Poter
Current Conditions				Grossnigs	7////
Total Particulates and Dust	Winter Maintenance	Fen/Seep/Spring		Biodiversity Area	
Under Study % Change Between Alternatives and Current Conditions	Stormwater Runoff			Deer Under Study	G
	Summary	Summary	Summary	Summary	
ummary - Environmental Sens	itivity		· Wildlife Habitats and	Crossings	
Air Quality			· Threatened, Endange	red & Sensitive Species	

· Water Quality

Wetlands

· Fish Habitats

· Geologic Hazards/Mining

	Communit	y Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- town Silver Plume Dillon Vail Number of Receptors Idaho George- town Silver Plume Dillon Vail Potential for Mitigation Idaho George- town Silver Plume Dillon Vail Vail	Community Areas Recreation (4(f)/6(f)) ///////////////////////////////////	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

Summary - Community Values

· Noise

 \cdot Land Use/Recreation/4(f) and 6(f)

 \cdot Cultural Resources/4(f)

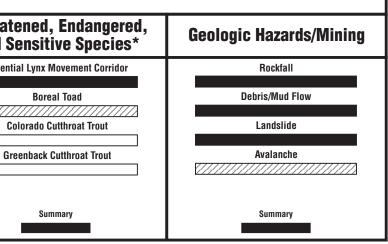
Legend

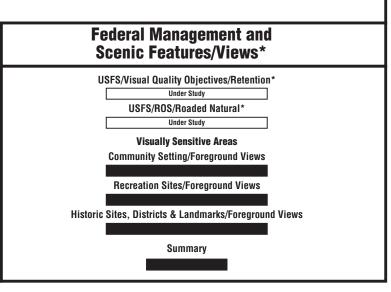
Level of Conflict

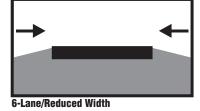
Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

* Applicable Federal Regulations (Refer to Table x) · Federal Management and Scenic Features/Views









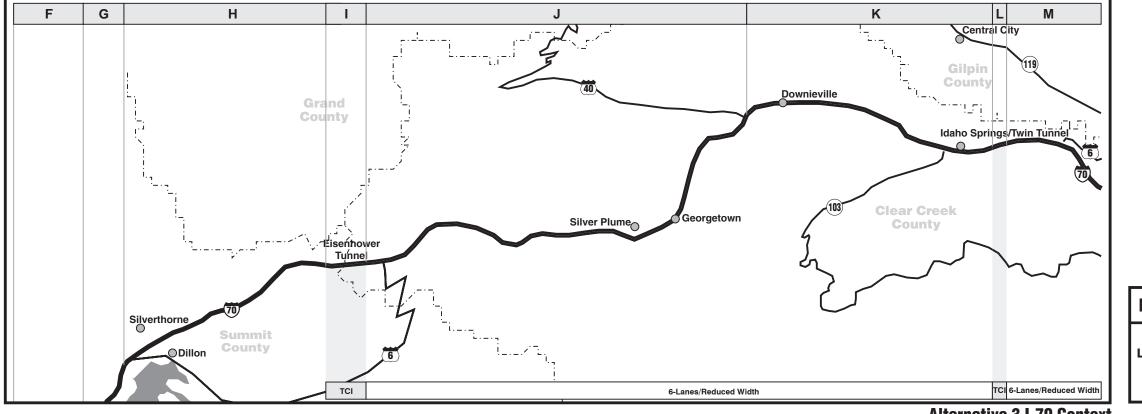


			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 3	0.56 LOS C	0.83 LOS D	65	61	0	0			<u> ////////////////////////////////////</u>

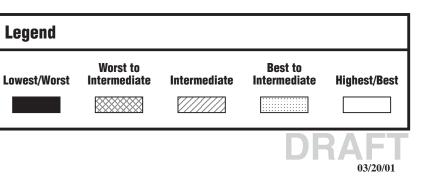
Description of Highway Alternatives

This Alternative is an option to Alternative 2, in which a reduced-width section is used to reduce impacts along the entire Corridor.





Alternative 3 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	
	Summary	Summary	Summary	Summary	



	Commun	ity Values	
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*	T
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail Z4-Hour Increase Idaho George- Springs Silver Plume Dillon Vail Mumber of Receptors Idaho George- Springs Silver Springs Dillon Vail Potential for Mitigation Idaho George- Springs Silver Potential for Mitigation Idaho George- Springs Silver Potential for Mitigation Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites	T
Summary	Summary	Summary	

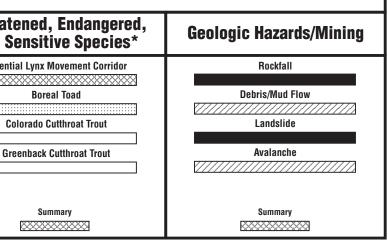
Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) Cultural Resources/4(f)

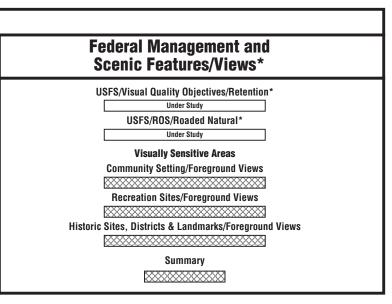
Legend

Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

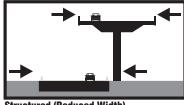












Structured (Reduced Width)

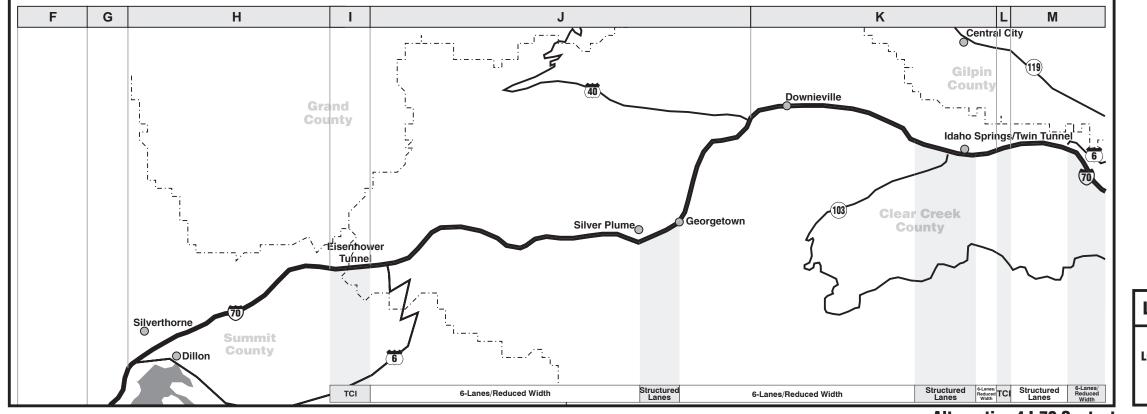
Description of Highway Alternatives

Same as Alternative 2, but with Reduced-width Structured Lanes at three sensitive locations.

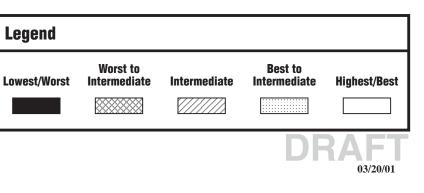
Tunnel Capacity Improvements (TCI) (Eisenhower Jefferson Memorial Tunnel and Twin Tunnels)

			Ne	ed	Safety		Implementation		
		Volume to Capacity Ratio		Speed		Duration of Congested Hours		Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 4	0.56 LOS C	0.83 LOS D	65	61	0	0			

Technical Summary:



Alternative 4 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and S
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range	Poter
	Summary	Summary	Summary	Summary	



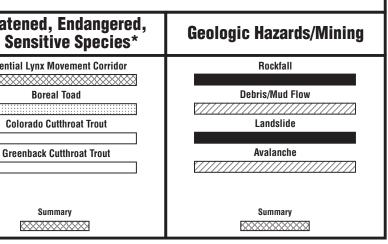
	Community V	Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Springs Silver Plume Dillon Vail Number of Receptors Idaho George- town Silver Plume Dillon Vail Potential for Mitigation Idaho George- town Silver Plume Dillon Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

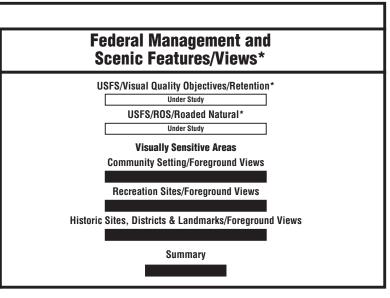
Legend

Level of Conflict

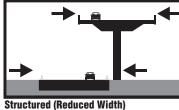
Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

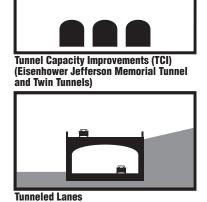










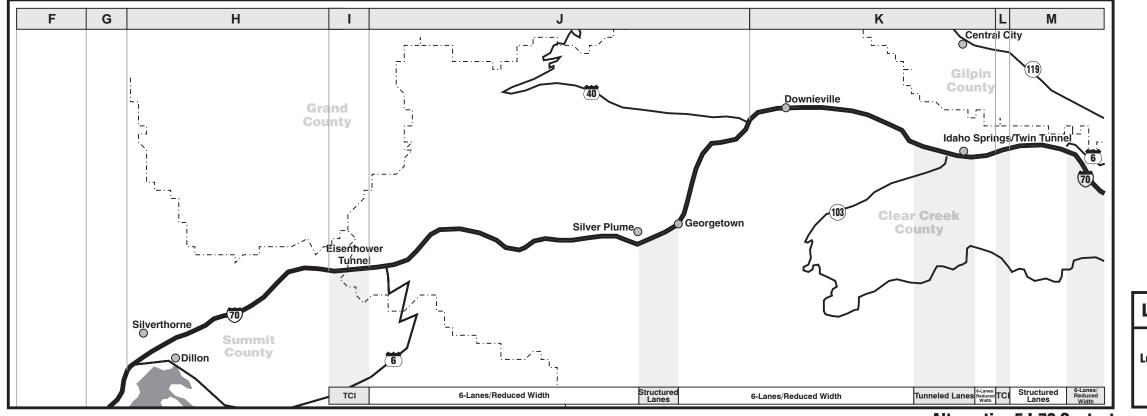


Description of Highway Alternatives

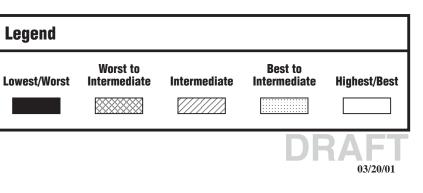
Same as Alternative 4, but with Tunneled Lanes through Idaho Springs.

			Ne	ed	Safety		Implementation		
		Volume to Capacity Ratio		Speed		Duration of Congested Hours		Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 5	0.56 LOS C	0.83 LOS D	65	61	0	0			<i>[]]]]]</i>

Technical Summary:



Alternative 5 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Crossings Biodiversity Area Under Study	Pote:
	Summary	Summary	Summary	Summary	



	Community	v Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- Silver Springs town Plume Dillon Vail 24-Hour Increase Idaho George- Silver Springs town Plume Dillon Vail Number of Receptors Idaho George- Silver Springs town Plume Dillon Vail Number of Receptors Idaho George- Silver Potential for Mitigation Idaho George- Silver Springs town Plume Dillon Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

 Summary - Community Values
 . Federal Management and Scenic Features/Views

 . Noise
 . Land Use/Recreation/4(f) and 6(f)

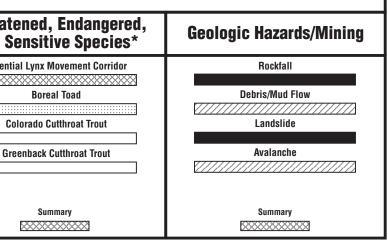
 . Cultural Resources/4(f)
 . Cultural Resources/4(f)

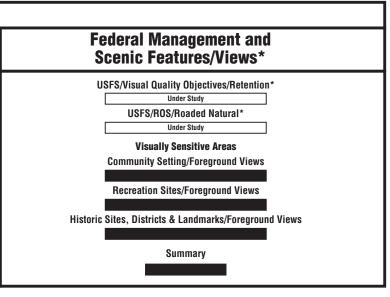
Legend

Level of Conflict

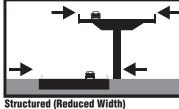
Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

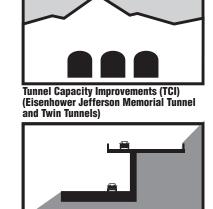












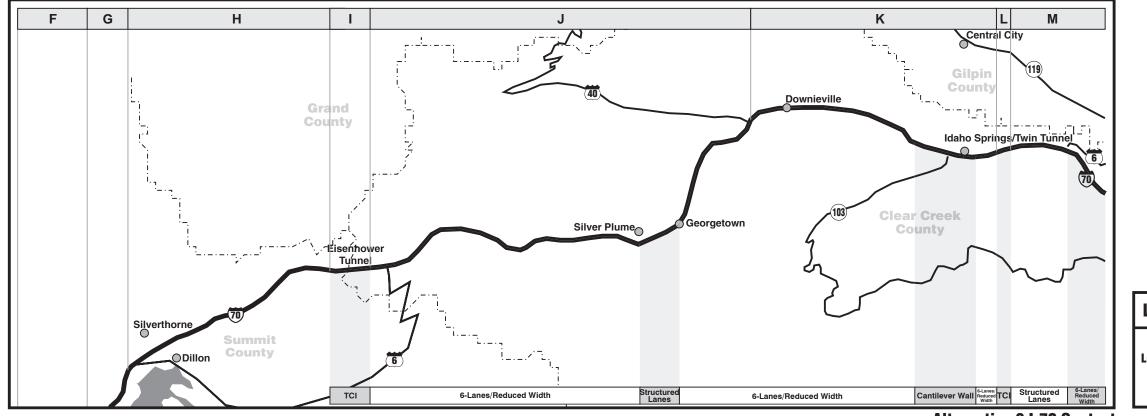
Cantilever Wall

Description of Highway Alternatives

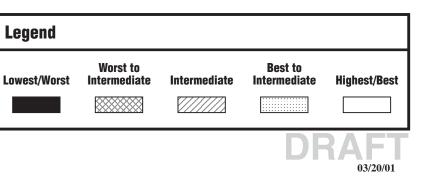
Same as Alternative 4, but with a Cantilevered Wall through Idaho Springs.

			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 6	0.56 LOS C	0.83 LOS D	64	61	0	0			

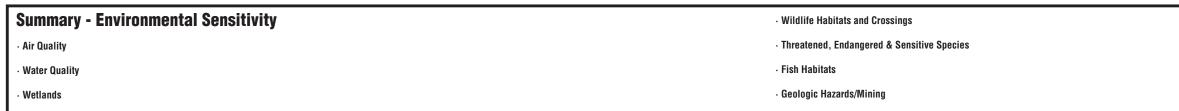
Technical Summary:



Alternative 6 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	Poter
	Summary	Summary	Summary	Summary	



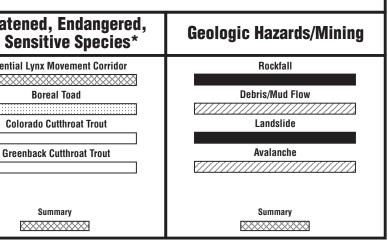
	Community	Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Silver Silver Plume Dillon Vail Number of Receptors Idaho George- Silver Silver Dillon Vail Number of Receptors Idaho George- town Silver Dillon Vail Potential for Mitigation Idaho George- town Silver Vail Potential for Mitigation Springs George- town Silver Vail	Community Areas Recreation (4(f)/6(f)) ///////////////////////////////////	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

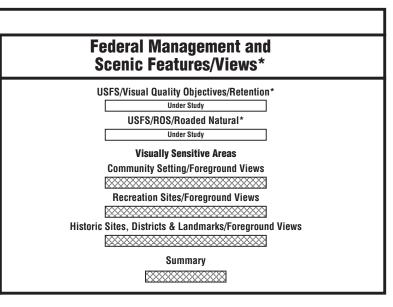
Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) Cultural Resources/4(f)

Legend

Level of Conflict

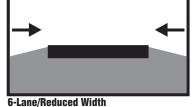
Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict



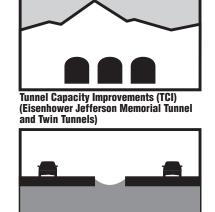




<u>Highway Alternative 7</u>







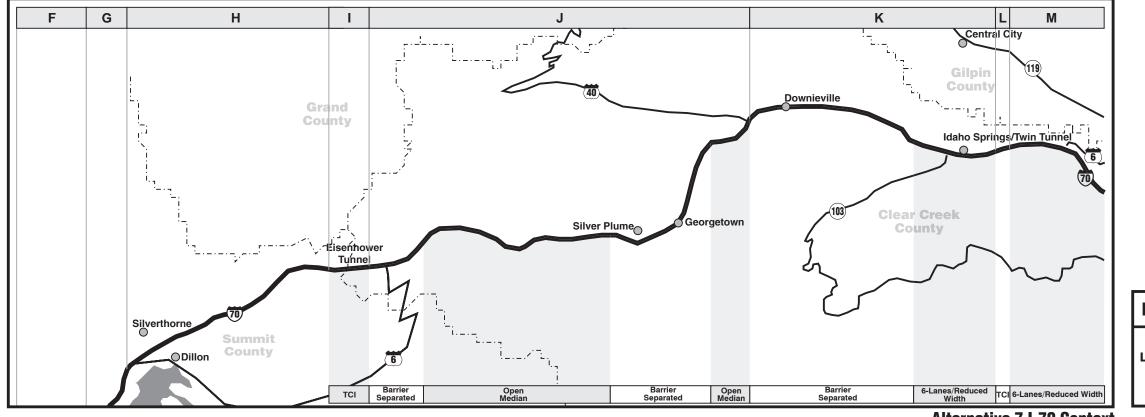
Open Median

Description of Highway Alternatives

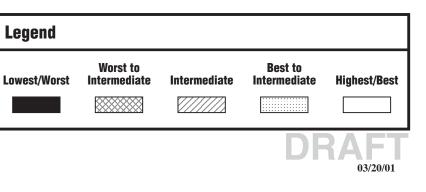
Same al Alternative 1, but with a Reduced-width section east of the Twin Tunnels.

			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Spi	eed	Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 7	0.56 LOS C	0.83 LOS D	65	61	0	0			<i>\////////////////////////////////////</i>

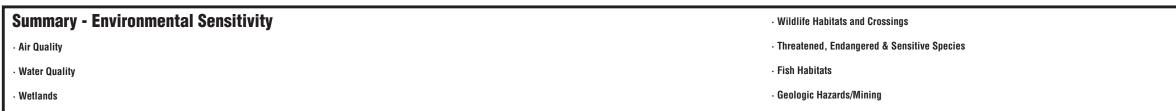
Technical Summary:



Alternative 7 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	
	Summary	Summary	Summary	Summary	



	Community	Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Springs Silver Plume Dillon Vail Mumber of Receptors Idaho George- town Silver Plume Dillon Vail Number of Receptors Idaho George- town Silver Plume Dillon Vail Potential for Mitigation	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Idaho George-Silver Springs town Plume Dillon Vail Summary	Summary	Summary

Summary - Community Values . Federal Management and Scenic Features/Views . Noise . Land Use/Recreation/4(f) and 6(f) . Cultural Resources/4(f) . Ederal Management and Scenic Features/Views

Legend

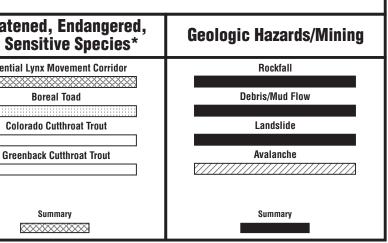
Level of Conflict

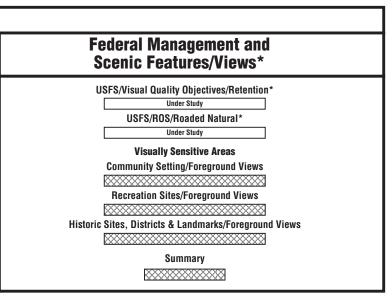
Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

* Applicable Federal Regulations (Refer to Table x)

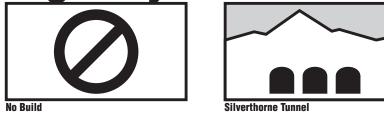
5-18







<u>Highway Alternative 8</u>

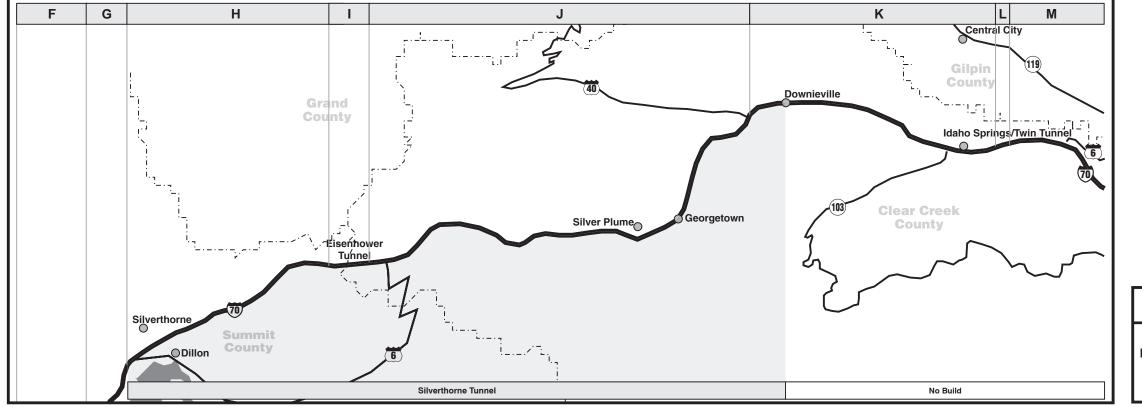


			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020							Not Identified	NA	NA
2020 Alternative 8									

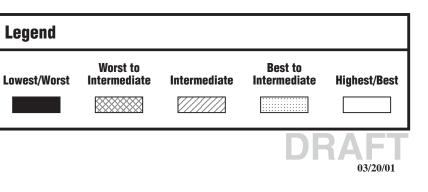
Technical Summary:

Description of Highway Alternatives

Tunnel from just east of Silverthorne to just west of the Empire Junction Interchange.



Alternative 8 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	
	Summary	Summary	Summary	Summary	



	Communit	y Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- Silver Springs town Plume Dillon Vail 24-Hour Increase Idaho George- Silver Springs town Plume Dillon Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails	Historic Districts Historic Sites & Trails Archaeological Sites
Number of Receptors Idaho George- Silver Springs town Plume Dillon Vail	Under Study	
Potential for Mitigation Idaho George- Silver Springs Town Plume Dillon Vail Summary	Summary	Summary

Summary - Community Values . Federal Management and Scenic Features/Views . Noise . Land Use/Recreation/4(f) and 6(f)

· Cultural Resources/4(f)

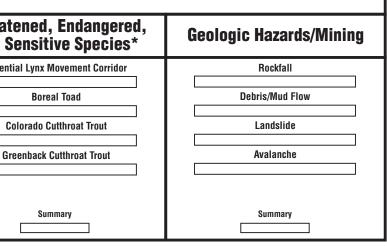
Legend

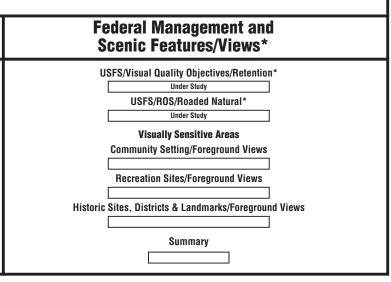
Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

* Applicable Federal Regulations (Refer to Table x)

5-20

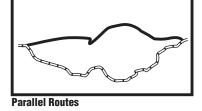






<u>Highway Alternative</u> 10



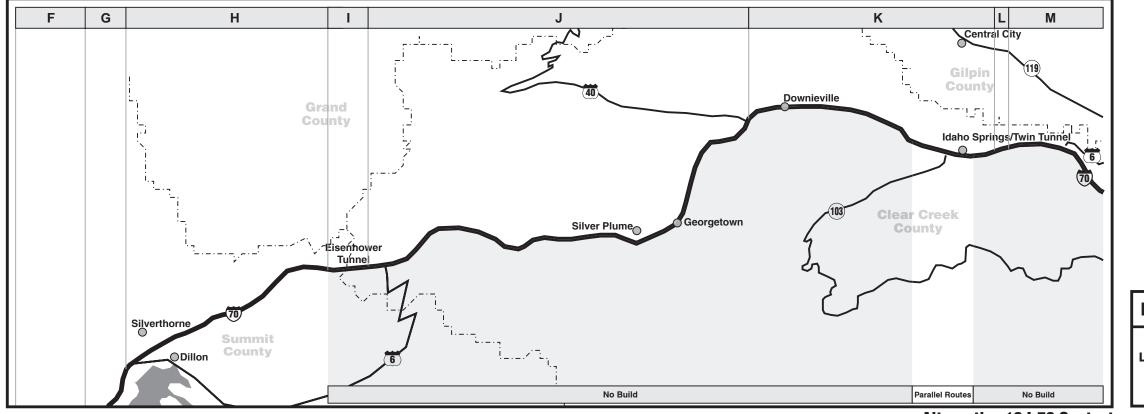


			Ne	ed	Safety		Implementation		
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020							Not Identified	NA	NA
2020 Alternative 10									

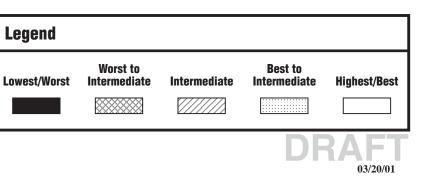
Technical Summary:

Description of Highway Alternatives

Relief routes around Idaho Springs. The specific use of these roads has not been evaluated; this analysis only investigated the possibility of another roadway platform.



Alternative 10 I-70 Context



			Environmental Sensitivity				
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and S		
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	Poter		
	Summary	Summary	Summary	Summary			
Summary - Environmental Sens	sitivity		· Wildlife Habitats and Cr	ossings			
· Air Quality			· Threatened, Endangered & Sensitive Species				
· Water Quality			· Fish Habitats				

· Wetlands

Potential

for Conflict

Potential for Conflict **Potential**

for Conflict

Potential

for Conflict

Potential

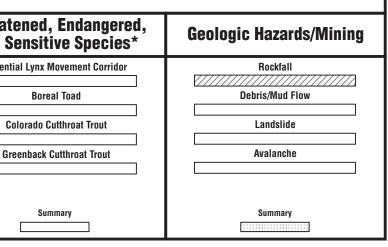
for Conflict

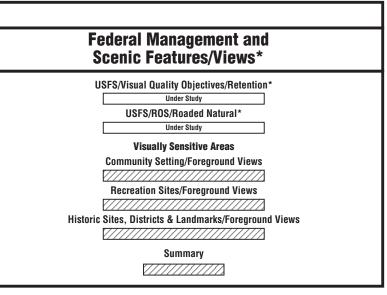
Fish Habitats

· Geologic Hazards/Mining

Community Values						
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*				
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Springs Silver Plume Dillon Vail Number of Receptors Idaho George- Springs Silver Plume Dillon Vail Potential for Mitigation Idaho Silver Springs Potential for Mitigation Idaho Silver Plume Dillon Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites Summary				
Summary						

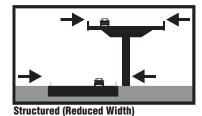
Summa	ry - Community Values			· Federal Management and Scenic Features/Views					
· Noise									
· Land Use/F	Land Use/Recreation/4(f) and 6(f)								
· Cultural Re	· Cultural Resources/4(f)								
Legend									
Level of Conflict				pplicable Federal Regulations	ns				
Greatest	Greatest - Intermediate Intermediate	Intermediate	1) Least	Refer to Table x)					











Description of Highway Alternatives

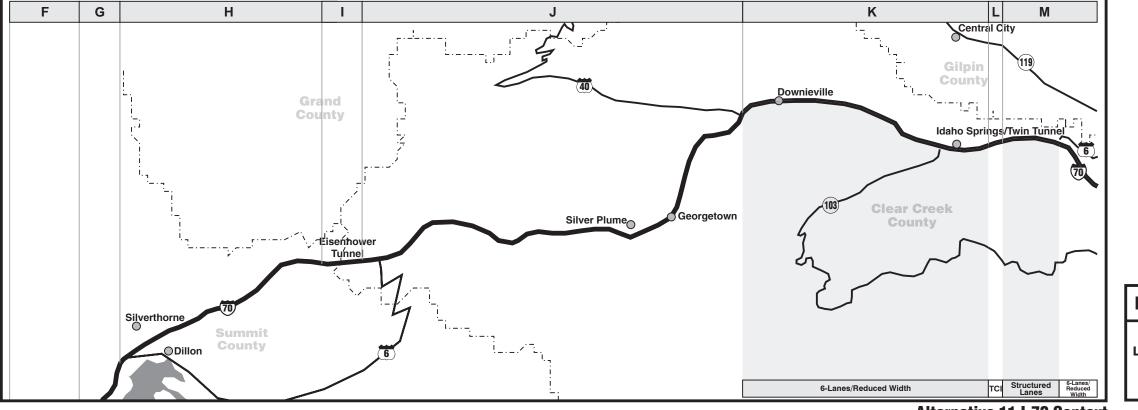
Tunnel Capacity Improvements (TCI) (Eisenhower Jefferson Memorial Tunnel and Twin Tunnels)



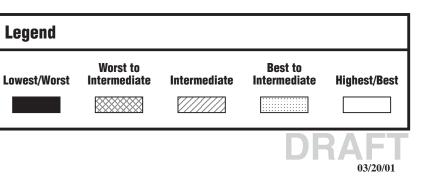
This Alternative is Reduced-width, except for Structured Lanes east of the Twin Tunnels.

			Ne	ed			Safety		Implementation
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 11	1.10 LOS F	0.82 LOS D	45	62	4	0			<i></i>

Technical Summary:



Alternative 11 I-70 Context



			Environmental Sensitivity			
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and S	
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	Poter	
	Summary	Summary	Summary	Summary		
Summary - Environmental Sen	sitivity	 Wildlife Habitats and Crossings Threatened, Endangered & Sensitive Species 				

Fish Habitats

· Geologic Hazards/Mining

· Water Quality

 \cdot Wetlands

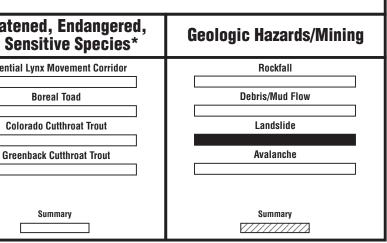
	Communi	ity Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- Springs Dillon Vail Z4-Hour Increase Idaho George- Silver Dillon Vail Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

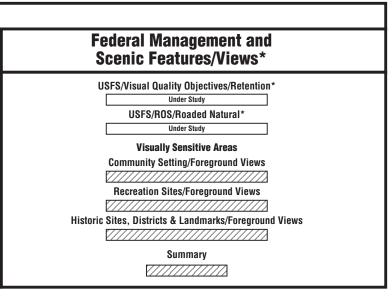
Summary - Community Values . Federal Management and Scenic Features/Views . Noise . Land Use/Recreation/4(f) and 6(f) . Cultural Resources/4(f) . Egend

Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

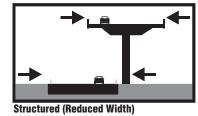




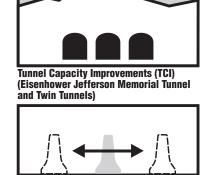




6-Lane/Reduced Width



Tunnel Capacity Improvements (TCI) (Eisenhower Jefferson Memorial Tunnel and Twin Tunnels)



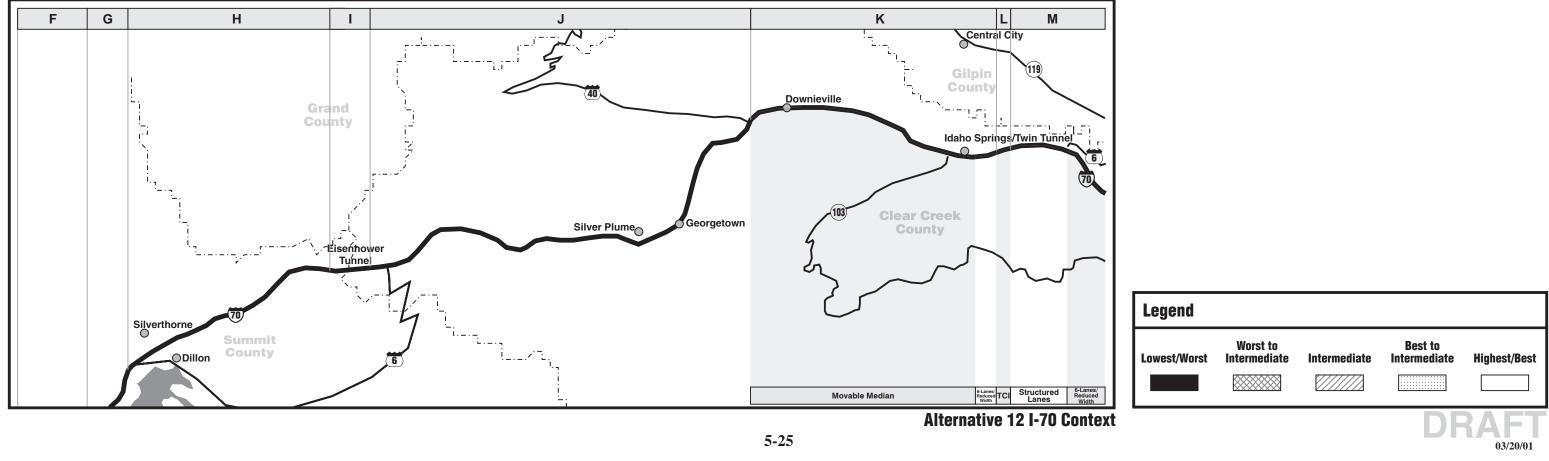
Movable Median

Description of Highway Alternatives

Same as Alternative 11, but using Movable Median through Idaho Springs instead of Reduced-width.

	Need						Safety		Implementation
	Volume to Capacity Ratio		Speed		Duration of Congested Hours		Accident Reduction	Cost	Constructability
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 12	1.10 LOS F	0.82 LOS D	45	62	4	0			<u> ////////////////////////////////////</u>

Technical Summary:



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions Solution Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	Poter
	Summary	Summary	Summary	Summary	
Summary - Environmental Sens	itivity		· Wildlife Habitats and C	rossings	
· Air Quality			· Threatened, Endangere	d & Sensitive Species	

· Fish Habitats

· Geologic Hazards/Mining

• Water Quality

 \cdot Wetlands

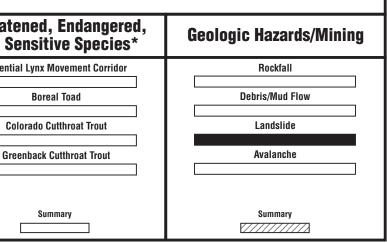
	Commun	ity Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Springs Silver Dillon Vail Vumber of Receptors Idaho George- Springs Silver Dillon Vail Vumber of Receptors Idaho George- Springs Silver Dillon Vail Vumber of Receptors Dillon Vail Vail Vail Potential for Mitigation Idaho George- Springs Silver Dillon Vail	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
//////////////////////////////////////	Summary	Summary

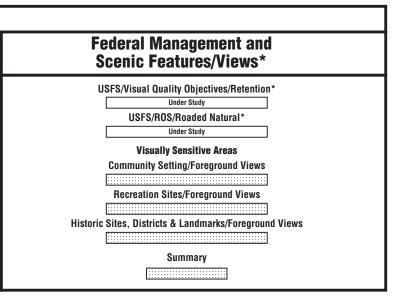
Legend

Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict



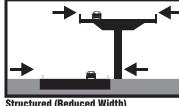




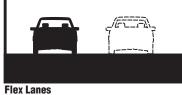
Highway Alternative 13



6-Lane/Reduced Width



Tunnel Capacity Improvements (TCI) (Eisenhower Jefferson Memorial Tunnel and Twin Tunnels)



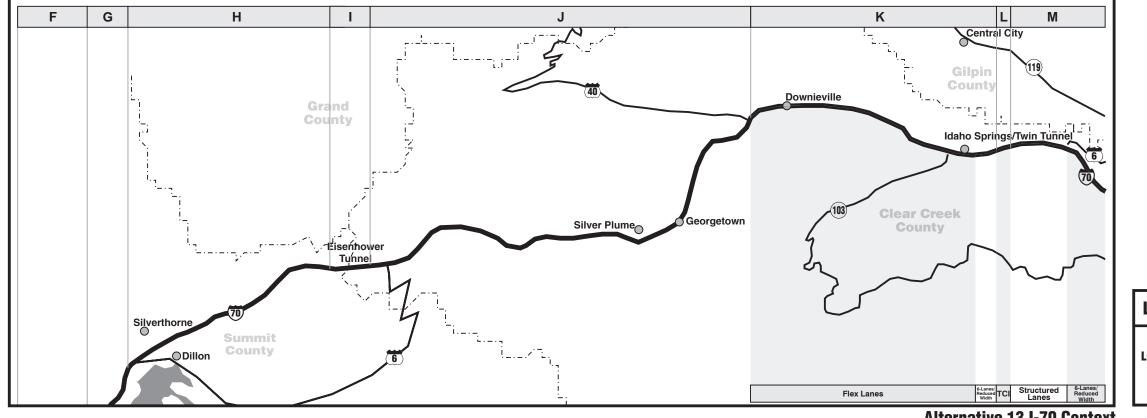
Structured (Reduced Width)

Description of Highway Alternatives

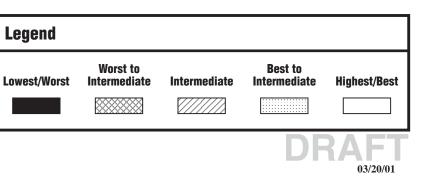
Same as Alternative 11, but using Flex Lanes through Idaho Springs instead of Reducedwidth.

			Ne	ed			Safety	Implementation	
	Volume to Speed Capacity Ratio		Duration of Congested Hours		Accident Reduction	Cost	Constructability		
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA
2020 Alternative 13	1.10 LOS F	0.82 LOS D	45	62	4	0			

Technical Summary:



Alternative 13 I-70 Context



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters Vegetated Wetlands Fen/Seep/Spring	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Elk and Big Horn Sheep Range Biodiversity Area Deer Under Study	Poter
	Summary	Summary	Summary	Summary	
Summary - Environmental Sens	sitivity		· Wildlife Habitats and C	ossings	
· Air Quality			· Threatened, Endangere	d & Sensitive Species	

· Fish Habitats

· Geologic Hazards/Mining

Water Quality

· Wetlands

	Communi	ity Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- Silver Springs town Plume Dillon Vail 24-Hour Increase Idaho George- Silver Springs town Plume Dillon Vail Number of Receptors Idaho George- Silver Springs town Plume Dillon Vail Vail </th <th>Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study</th> <th>Historic Districts Historic Sites & Trails Archaeological Sites</th>	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

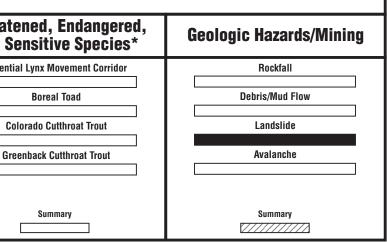
Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) · Cultural Resources/4(f)

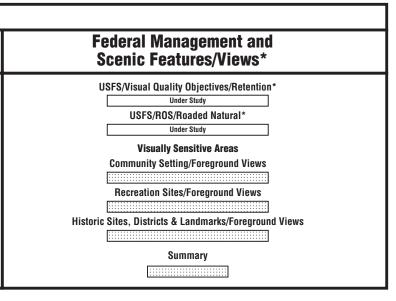
Legend

Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

* Applicable Federal Regulations (Refer to Table x)



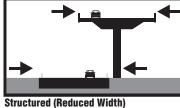


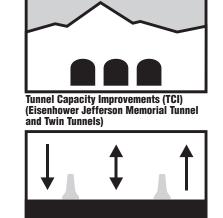


Highway Alternative 14



6-Lane/Reduced Width





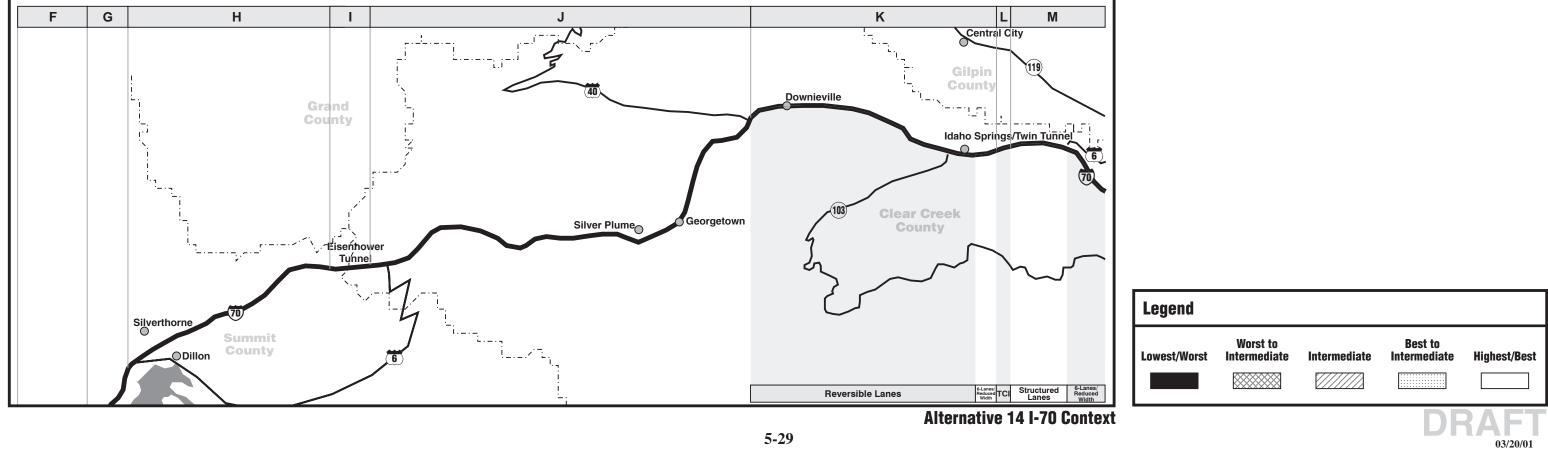
Reversible Lanes

Description of Highway Alternatives

Same as Alternative 11, but using Reversible Lanes through Idaho Springs instead of Reduced-width.

			Ne	ed			Safety	Safety Implementation			
	Volume to Speed Capacity Ratio		Duration of Congested Hours		Accident Reduction	Cost	Constructability				
	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential				
No Build/ 2020	1.05 LOS F	1.10 LOS F	29	25	4	5	Not Identified	NA	NA		
2020 Alternative 14	1.10 LOS F	0.82 LOS D	45	62	4	0					

Technical Summary:



			Environmental Sensitivity		
Air Quality*	Water Quality*	Waters of the U.S./Wetlands*	Fish Habitats	Wildlife Habitats and Crossings	Threa and S
Total Emissions Under Study % Change Between Alternatives and Current Conditions Total Particulates and Dust Under Study % Change Between Alternatives and Current Conditions	Mine Tailings/Waste Rock Mineralized Rock Winter Maintenance Stormwater Runoff	Open and Flowing Waters	High Value Fishery Gold Medal Fisheries	Elk and Big Horn Sheep Range Crossings Biodiversity Area Deer Under Study	Poter
	Summary	Summary	Summary	Summary	
Summary - Environmental Sen	sitivity		· Wildlife Habitats and Cr	ossings	
· Air Quality			· Threatened, Endangered	d & Sensitive Species	
· Water Quality			· Fish Habitats		

· Wetlands

· Geologic Hazards/Mining

	Commun	ity Values
Noise*	Community/Recreation/ 4(f) and 6(f)*	Cultural Resources/4(f)*
Peak Hour Increase Idaho George- town Silver Plume Dillon Vail 24-Hour Increase Idaho George- Springs Silver town Dillon Vail Number of Receptors Idaho George- Springs Silver town Dillon Vail Vall Vall	Community Areas Recreation (4(f)/6(f)) Hike and Bike Trails Under Study	Historic Districts Historic Sites & Trails Archaeological Sites
Summary	Summary	Summary

Summary - Community Values · Federal Management and Scenic Features/Views Noise · Land Use/Recreation/4(f) and 6(f) · Cultural Resources/4(f)

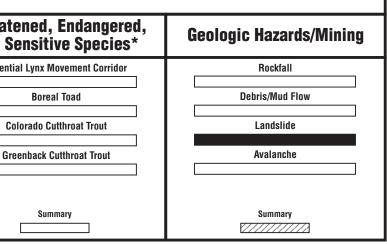
Legend

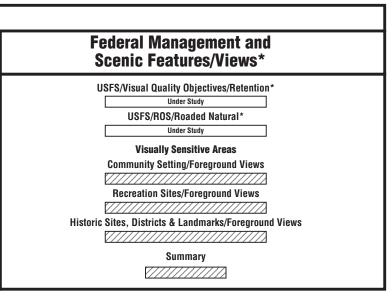
Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

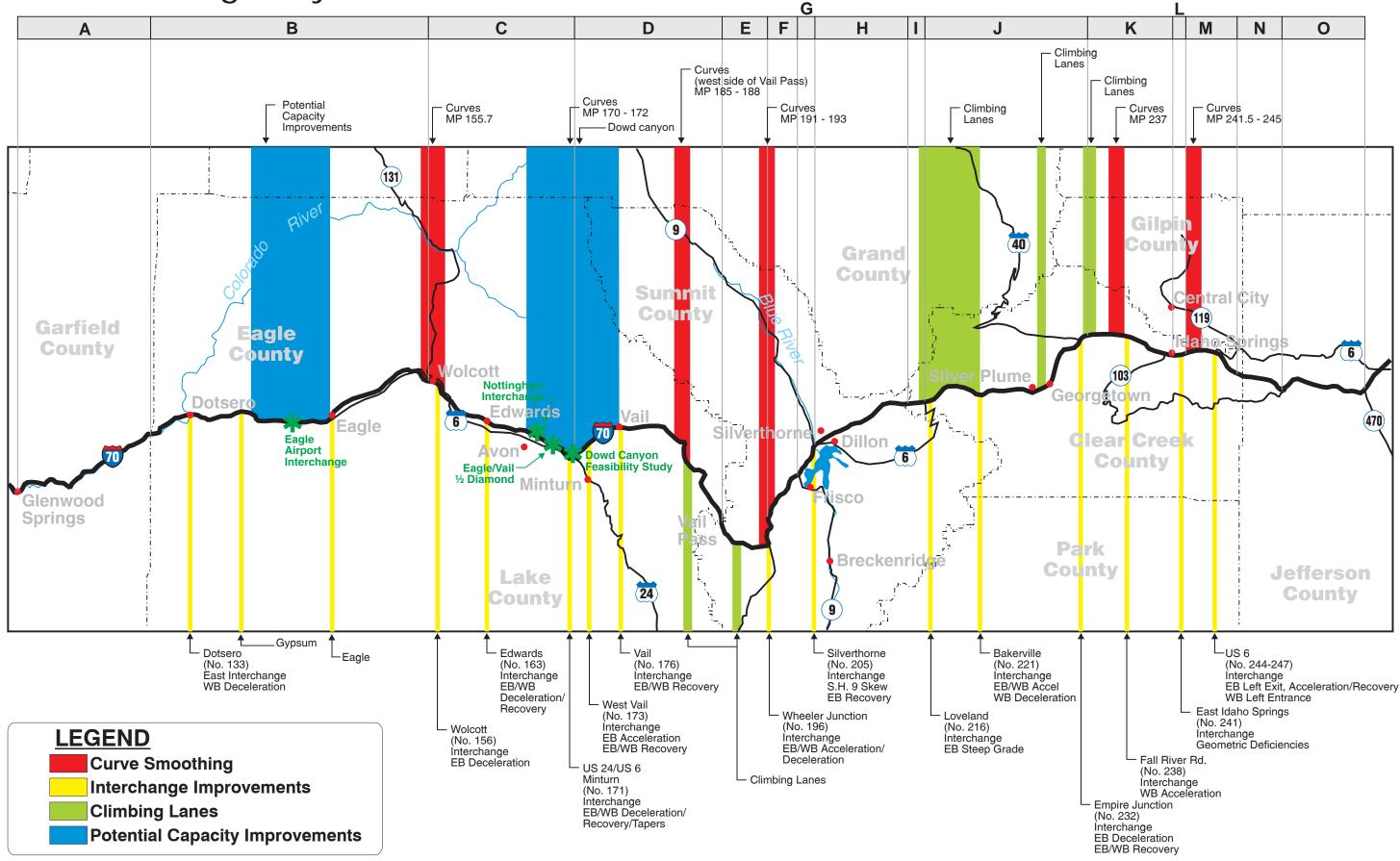
* Applicable Federal Regulations (Refer to Table x)







Localized Highway Alternatives



DRAFT

	Localized Hig	<u>hway Alte</u> rnativ	/es				Evaluation Cr	iteria		
Description of Alternative	Description of Improvements	Mile Point	Problematic Area Definition	Potential Benefit	V/C	Speed	Congestion Duration	Safety	Cost	Constructib
CURVE SMOOTHING	Increase design speed of all curves to 65 mph.	See Below	Curves with Design Speed < 65 mph	Increase Safety		-				
Wolcott	60' lateral shift to the north.	155.70	Existing MDS = 55 mph, radius = $1146'$	Increase Safety						
Dowds Junction/Minturn	105' lateral shift to the South. Located in the vicinity of a slide area.	170.34	Existing MDS = 55 mph, radius = 1146	Increase Safety						
	124' lateral shift to the North. Located in the vicinity of a slide area.	170.68	Existing MDS = 55 mph, radius = 1146'	Increase Safety						
	153' lateral shift. Requires reconstruction of Dowd Jct. Interchange.	171.11	Existing MDS = 55 mph, radius = 1146'	Increase Safety						
	46' lateral shift to the South would require filling onto a steep slope. 16' lateral shift to the North. Requires cut into the mountain.	171.58 171.77	Existing MDS = 55 mph, radius = 1146' Existing MDS = 55 mph, radius = 1146'	Increase Safety Increase Safety						
West Side of Vail Pass	34' lateral shift. Requires replacing existing bridges w/ new ones.	185.40	Existing MDS = 50 mph, radius = 1140 Existing MDS = 60 mph, radius = 1273'	Increase Safety						
	26' lateral shift to the North. Would require a cut into the hillside.	186.40 186.27	Existing MDS = 60 mph, radius = 1273' Existing MDS = 60 mph, radius = 1206'	Increase Safety Increase Safety						
	37' lateral shift to the North. Would require a cut into the hillside.	188.00	Existing MDS = 55 mph, radius = 1146'	Increase Safety						
East Side of Vail Pass	17' lateral shift to the North. Would require a cut into the hillside.	191.18	Existing MDS = 55 mph, radius = 1146 '	Increase Safety						
	19' lateral shift to the South. Would require filling onto the slope.	191.46 WB	Existing MDS = 55 mph, radius = 1146 '	Increase Safety						
	32' lateral shift to the North. Would require a cut into the hillside.	192.09 WB	Existing MDS = 55 mph, radius = 1146 '	Increase Safety						
	23' lateral shift to the North. Would require a cut into the hillside.	192.32 WB	Existing MDS = 55 mph, radius = 1146'	Increase Safety						
Fall River Road	Lateral shift of between 14' and 76'. Would require either a cut into the North hillside or fill over the river to the South.	237.14-237.86	Various curves have existing MDS = 55 mph, radius = 716' or 1146'	Increase Safety						
Twin Tunnels	Refer to Transystem's Study	241.5-245.6	Various curves have existing MDS = 45 mph.	Increase Safety						
NTERCHANGE IMPROVEMENTS	Make modifications to improve interchange operations.	See Below	See Below	Increase Safety						
Dotsero	Increase WB decel lane at east interchange. Could possibly combine east and west split diamonds into one single diamond.	133.0	West interchange is OK; East interchange- the WB deceleration lane is inadequate.	Increase Capacity						
Gypsum & Eagle	Increase ramp terminal traffic signal capacity.	140.0 / 147.0	Ramp terminal signal capacity is inadequate.	Increase Capacity						
Wolcott	Increase EB decel lane length	156.0	The EB off ramp has an inadequate deceleration lane.	Increase Capacity						
Edwards	Increase EB & WB decel lengths. Increase WB recovery lane length.	10010	The WB off ramp has an inadequate deceleration lane and recovery lane. EB off-ramp has an inadequate deceleration lane.	Increase Capacity						
US 24/US 6/Minturn/Dowd Jct.	The new Eagle Vail 1/2 diamond interchange will improve traffic concestion at both Avon and Dowd Jct. Interchanges.	171.0	WB and EB off-ramp has an inauequate deceleration rane. WB and EB off-ramps at Dowd Jct. interchange have inadequate decel and recovery lanes. EB on-ramp has a sharp curve, MDS=20 mph.	Increase Capacity						
West Vail	Increase the taper length of accel and decel lanes. EB accel lane is too short. Incr. recovery lengths on both decel lanes.	173.0	EB acceleration lane is too short. Recovery lanes on both WB and EB deceleration lanes are too short.	Increase Capacity						
Vail	Increase taper lengths of accel and decel lanes from 250' to 300'.	176.0	Taper lengths of acceleration and deceleration lanes are too short.	Increase Capacity						
Wheeler Junction	Increase recovery lanes on both WB and EB deceleration lanes to Both WB and EB acceleration and deceleration lanes should be lengthened.	196.0	Recovery lanes on both WB and EB deceleration lanes are too short. All accel and decel lanes are too short. WB on-ramp has a sharp curve, MDS = 20 mph. Also, the compound curves should be modified.	Increase Capacity						
SH 9 / Silverthorne	Lengthen EB recovery lane length.	205.0	The EB recovery lane length is too short. Align skews potential problem.	Increase Capacity						
Loveland	Investigate grade reduction.	205.0	Steep downgrade on EB.	Increase Capacity						
Bakerville	Lengthen WB and EB acceleration lanes and WB deceleration lane.	221.0	WB and EB accel lanes and the WB deceleration lanes are too short.	Increase Capacity						
Empire Junction	Lengthen EB deceleration lane. Improve recovery lanes. Check geometry for possible improvements.	232.0	The EB deceleration and recovery lanes are too short. EB off-ramp has a sharp curve, MDS=20mph. Excessive compound curve.	Increase Capacity						
Fall River Road	Lengthen WB acceleration lane.	238.0	The WB acceleration lane is inadequate.	Increase Capacity	1	1				
East Idaho Springs	Lengthen acceleration and deceleration lanes. Improve geometry.	241.0	Accel and decel lanes are inadequate. Very sharp curves for ramps, MDS=10mph-20mph. WB accel and decel lanes are too close together.	Increase Capacity		1				
US 6	A "left exit" to US 6 and a "left entrance" ramp to I-70 WB are used.	244.0	The "left exit" to US 6 and the "left entrance" to I-70 WB are not	Increase Capacity						
Top of Floyd Hill (Hyland Hills)	The accel lane and recovery lane at Floyd Hill should be lengthened. The accel lane and recovery lane at Floyd Hill should be lengthened.	247.0	desirable. The accel and recovery lanes at Floyd Hill should be longer. The accel lane and recovery lane at Floyd Hill should be lengthened.	Increase Capacity						
		On a Balance		have a first the						<u> </u>
CLIMBING LANES	Add an additional uphill lane on steep grades and where the proximity of adjacent accel and decel lanes makes it difficult for slow-moving vehicles to achieve the proper speed for a safe lane	See Below	Slow-moving vehicles on steep grades reduce I-70's capacity. Climbing lanes will improve the (v/c) ratio. It can cause problems when slow- moving vehicles can't obtain a proper speed before merging.	Increase Capacity						
West Side of Vail Pass	Eastbound climbing lanes.	181.0-188.0	Slow moving vehicles on grades cause capacity reduction.	Increase Capacity	1	1	<u> </u>			<u> </u>
East Side of Vail Pass	Westbound climbing lanes.	190.0-195.5	Slow moving vehicles on grades cause capacity reduction.	Increase Capacity	1	1				I
Eisenhower Tunnels to Bakerville	Westbound climbing lanes.	215.0-221.2	Slow moving vehicles on grades cause capacity reduction.	Increase Capacity						
Georgetown Hill	Westbound climbing lanes.	226.0-228.0	Slow moving vehicles on grades cause capacity reduction.	Increase Capacity	1	1				I
Downieville to Empire Junction	Create a continuous auxiliary lane between the two interchanges.	232.5-233.7	Slow moving venicles on grades cause capacity reduction. Slow moving vehicles on grades cause capacity reduction and trucks entering from the weigh station cause weaving problems at US 40 exit.	Increase Capacity	1					

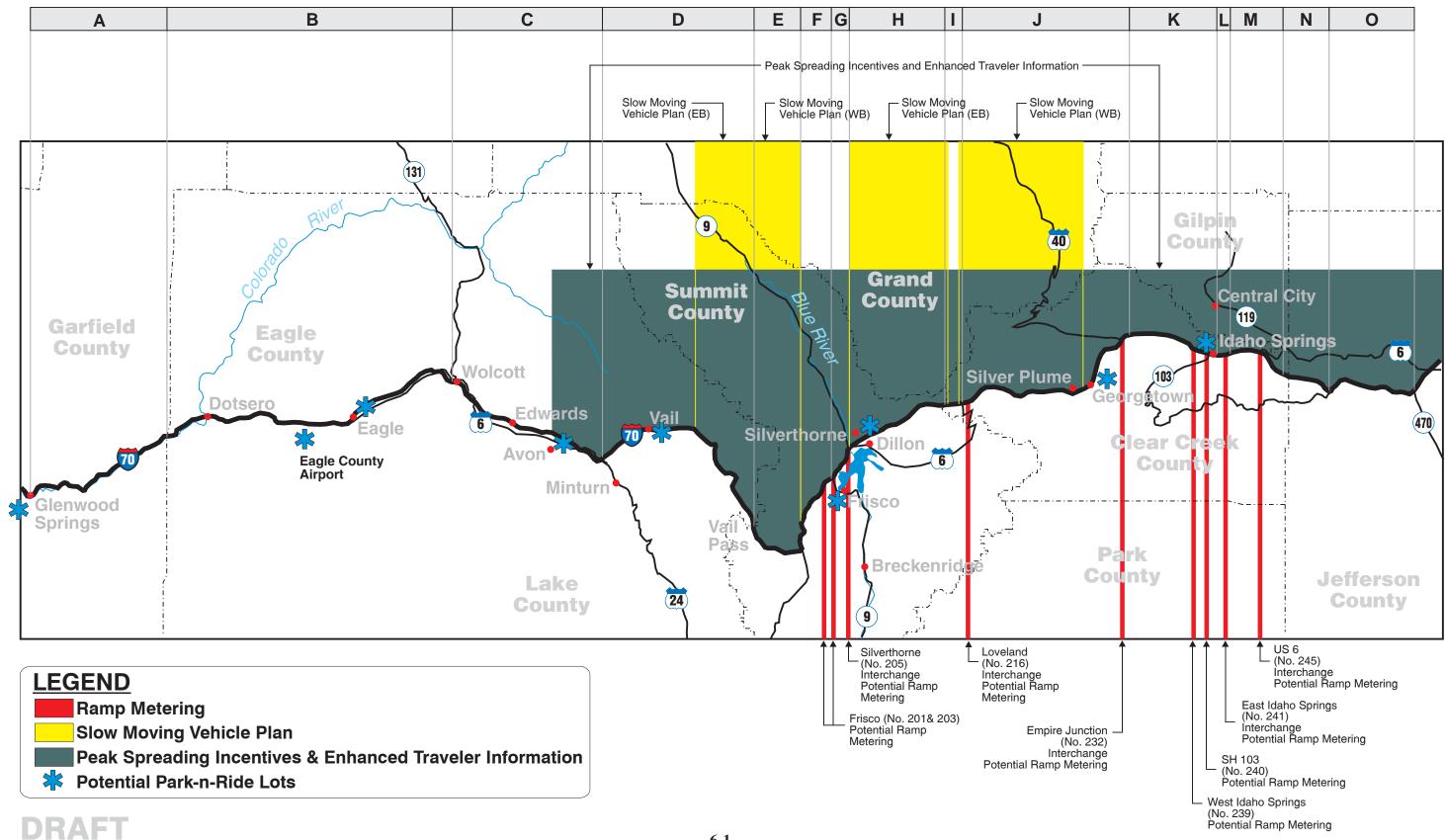
6 – TRANSPORTATION SYSTEM MANAGEMENT



Transportation Management Family

(Including Transportation System Management and Travel Demand Management)

Potentially Mitigate the Need For Constructing a Third Bore at The Eisenhower/Johnson Memorial Tunnels by Improving Travel Efficiency, or by Reducing Peak-Hour Travel Demand.



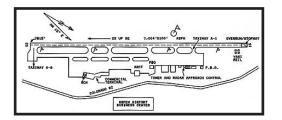
	Transportation Man	<u>agement Al</u>	ternatives				Evaluation Cri	teria		
Description of Alternative	Description of Improvements	Mile Point	Problematic Area Definition	Potential Benefit	V/C	Speed	Congestion Duration	Safety	Cost	Constructibi
MINOR HIGHWAY	Make alterations near certain highway interchanges, as necessary	See Below	Traffic entering I-70 at interchanges can overload the highway	Reduce Overall						
IMPROVEMENTS AWAY FROM	to set up a ramp metering operation, such as currently exists at		capacity and help cause congested flow. Ramp metering controls the	System Congestion						
THE MAINLINE	many locations in Metro Denver.		rate at which vehicles enter I-70.							
Frisco Interchanges (East & West)	Potential Ramp metering location. Would only apply to the EB dir.	201 & 203	Congested traffic flow occurs periodically.	Reduce Congestion						
Silverthorne Interchange	Potential Ramp metering location. Would only apply to the EB dir.	205.00	Congested traffic flow occurs periodically.	Reduce Congestion						
Loveland Interchange	Potential Ramp metering location. Might apply to both directions.	216.00	Congested traffic flow occurs regularly.	Reduce Congestion						
Empire Junction Interchange	Potential Ramp metering location. Would only apply to the EB dir.	232.00	Congested traffic flow occurs frequently.	Reduce Congestion						
West Idaho Springs Interchange SH 103 Interchange	Potential Ramp metering location. Might apply to both directions. Potential Ramp metering location. Might apply to both directions.	239.00 240.00	Congested traffic flow occurs frequently. Congested traffic flow occurs frequently.	Reduce Congestion Reduce Congestion						
East Idaho Springs Interchange	Potential Ramp metering location. Might apply to both directions.		Congested traffic flow occurs frequently.	Reduce Congestion						
US 6 Interchange	Potential Ramp metering location. Would only apply to the WB dir.	245.00	Congested traffic flow occurs periodically.	Reduce Congestion						
PASSIVE MANAGEMENT	Involves no highway construction, other than new signing.	See Below	Decrease congestion by reducing the V/C ratios. The Slow-Moving	Reduce Congestion						
STRATEGIES	Enforcement would be required for some of the ideas to be		Vehicle plan is a TSM idea that would increase the Capacity (C) and	nouro congestion						
STRATEGIES	effective.		the Peak Spreading Incentives are a TDM idea that would decrease the							
			Volume (V) during Peak Hours.							
PEAK SPREADING INCENTIVES	Through the coordinated efforts of stakeholders throughout the		Travelers on I-70 are experiencing high levels of congestion, primarily	Reduce Peak Hour						
	corridor, reduce peak hour travel through the use of incentives to		during the winter and summer travel periods. The congestion,	Travel Demand and						
	alter people's travel behavior. Changes could involve the hour or	-	however, occurs only during a small percentage of the week. Traffic	decrease Congestion						
	day during which people travel. An example of one such idea currently in practice involves inexpensive late season monthly or		data currently shows a reduction in winter congestion, as compared with the summer, due to self-imposed travel demand management.							
	season ski passes that allow user's to vary their travel schedules.		A focused, coordinated program could prove to be effective.							
SLOW-MOVING VEHICLE PLAN	Potential ideas include a restriction on peak hour, peak direction	See Below	An ideal 4 lane highway carries 4400 vehicles per hour in each	Increase Peak Hour						
	travel by slow-moving vehicles in certain stretches of the corridor.		direction. Factors on I-70, other than heavy vehicles, drop the	Travel Capacity and						
	High-powered buses that could hold a minimum speed of 55 - 60		capacity to about 3400 vehicles per hour. The Eisenhower / Johnson	decrease Congestion						
	mph throughout steep grades could potentially be provided to local transit services. If a truck could maintain a minimum speed of 50-		Tunnels have a maximum reported traffic volume of about 2150 vph WB and 2600 vehicles per hour EB. This type of plan could provide							
	55 mph throughout those grades, such as if it were on an empty		significant increase in WB capacity. The current highway can't handle							
	return trip, then the restriction wouldn't apply to them. Additional		increases in EB traffic, because the congestion occurs where the							
	chain-up, rest area, WIM and AVI facilities area could be provided.		grades are fairly level or slightly downhill.							
West side of Vail Pass	Would involve restrictions in the EB direction		According to the Highway Capacity Manual, a 4 lane	Reduce Congestion						
East side of Vail Pass	Would involve restrictions in the WB direction	195 - 190	highway with 0% slow-moving vehicles can handle 28%	Reduce Congestion						
			more traffic than one with only 2% trucks.							
Western Approach to Eisenhower	Would involve restrictions in the EB direction	205-214	This alternative would work well with highway alternatives that add	Reduce Congestion						
			additional EB capacity by adding new lanes.							
Eastern Approach to Eisenhower	Would involve restrictions in the WB direction	228 - 216	The volumes in the Eisenhower Tunnels are not limited by the tunnels,	Reduce Congestion						
			but rather by the steep highways on either side.							
PARK-N-RIDE LOTS	Construct additional park-n-ride lots, similar to the one at the		Decrease congestion by increasing the average vehicle occupancy,	Reduce Congestion						
	Hogback, that would allow people to ride-share, thus reducing the number of vehicles on the highway.		thus reducing the number of cars on the road.							
		the map		Deduce Orwerstien						
ENHANCED TRAVELER	This alternative would involve exploring the benefit of providing additional funding beyond that currently allocated for traveler and	•	Provide travelers with info to help them to pick a time for their trip when they can avoid congestion. Inform them about incidents up	Reduce Congestion and Improve Safety						
INFORMATION	agency information related to 1-70 travel. Ideas that provided useful		ahead. Allow them to alter their travel plans while they can still make	and improve dately						
	info to the users at convienient places, such as at home, on the road		changes. Provide CDOT with more info so they can provide quicker							
	or at ski areas will be investigated.		incident response.							
BICYCLE IMPROVEMENTS	Improve the continuity and safety of bicycle travel throughout the	-	Currently cyclists are required to make unpleasant choices to get	Improve Safety						
	corridor.	corridor	through some parts of the corridor. There are many areas where the							
			motorist / cyclist interface can be improved.							
NO ACTION	This alternative explains the portions of the Incident Management		CDOT has just completed plans for both of these areas. These plans	Improve Safety						
	Plan and the Traveler Information Plan for this corridor for which	corridor	include many ideas which will provide a safer and more pleasant							
	funding had been identified.		traveling experience to the public. The implementation of many of these ideas will occur, regardless of the outcome of this study.							
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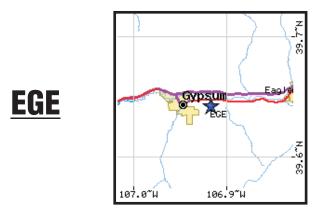
7 – AVIATION

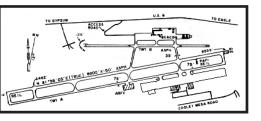
Aviation	Ne	ed	Implemer	itation
Improvements DRAFT	Number of Additional Air Passengers Accommodated	Number of Vehicles Removed From I-70 per day During Peak Season	Cost	Technology
Improve Existing Commercial Aviation Airports Through Advance Technology to Allow Additional Flights	Estimates Range From: 500 - 1,000 6,100 - 7,000	Estimates Range From: 200 - 400 2,350 - 2,700	\$4 - \$6 Million for the ASR-11 \$175,000 to \$185,000 for Improved Instrument Landing System for HDN	Raytheon was awarded a joint procurement contract in 1996 with the DOD and FAA to develop the ASR-11 - the next generation ASR after ASR-9. This navigational aid has been extensively testedat Elgin AFB for two Years. ILS available from numerous producers and distributors
Improve General Aviation Facilities	Included in Above	Included in Above	See Above	Raytheon was awarded a joint procurement contract in 1996 with the DOD and FAA to develop the ASR-11 - the next generation ASR after ASR-9. This navigational aid has been extensively tested at Elgin AFB for two Years. ILS available from numerous producers and distributors. Additionally, the ability to accommodate commercial service is not desired by GA facilities; rather the ability to meet burgeoning demand for better GA facilities is needed.
Develop Systems Management and Subsidy Programs			\$3 - \$5 Million Annually	N/A

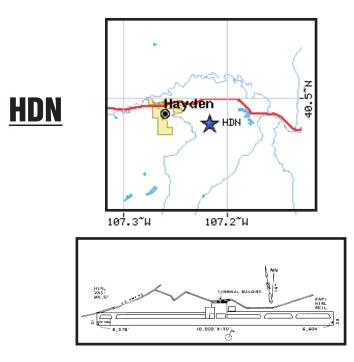












DEFINITION OF ALTERNATIVES

Improve Existing Commercial Aviation Facilities

Longer runways have the potential to boost airport operations, but there is general concurrence that improved navigational aids can do more to "grow the capacity" of mountain airports than any other capital investment. One navigational aid being considered for EGE, is the ASR-11. It has been reported that one ASR-11, strategically located, also could improve operations at ASE (Aspen-Pitkin County Airport) and Glenwood Springs Airport (a general aviation facility where where demand is outstripping supply). Reportedly, there is no airspace conflicts with HDN, therefore, The ASR-11 has limited benefits for that airport.

Improve General Aviation Facilities

Similar to improvements to commercial service airports, the identified improvement is better airport surveillance radar to accommodate the rapidly growing general aviation traffic.

Develop Systems Management and Subsidy Programs

The subsidy program identified as most likely to boost air travel, are seat guarantees, currently paid by the ski resorts to the airlines does not achieve its desired load factor.

Resorts contract with an airline or airlines to ensure service and routes are continued by paying "seat guarantees". The contracted amount is only paid by the resorts to the airlines if the airline does not meet their projected load factor or profitability for a particular flight or route.

Presently, air travel demand is so great, that the airlines have met their load factors, and none of the resorts have had to fulfill their "seat guarantee" agreements

DEFINITION OF CRITERIA AND MEASURES

Additional Air Passengers

EGE could accommodate twice as many flights during their peak hours (10am to 3pm, Saturday, 100-day winter season). It also has been maintained (and two airport managers concurred) that without navigational aids, 500 to 1,000 person trips would be added daily to I-70 during the 100-day winter season. Officials at DIA, estimate that diversions are greater, and projected 6,100 to 7,000 person trips would be added daily to I-70 during the 100-day winter season.

Number of Vehicles Removed from I-70?

Range of additional person trips divided by an average vehicle occupancy of 2.6.

<u>Cost</u>

Based on estimated by FAA, CDOT Aeronautics Division, Airport Operators and Resort operators.

Technology

ASR-11 is an airport surveillance radar with primary surveillance coverage to 60 nautical miles and secondary surveillance coverage to nautical 120 miles. It provides improved detection in clutter and weather, increased reliability and low life-cycle, costs, and it further can detect six levels of weather.

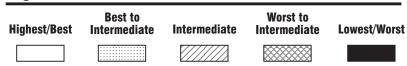
The improved ILS for HDN would include an RVR. None of the airports currently has these navaids programmed in their six-year capital plans. (HDN references improved ILS 2007 ans beyond).



8 – SUMMARY

Fixed Guideway Transit Alternative		Need								Implem	entatio	n	
Transit Alternative	Cap	tem acity (Hour)	System Attractiveness)		erage Deed	Connectivity	Connectivity Feeder/Distribution Requirements		Costs	Technology Available	F	uel	Energy Consumption
	Actual	Rating		Actual	Rating	1					Avail	Limit	1
Highway Alignment - Diesel Power													
· LRT - Single	1416			46.1					1		8		
· LRT - Double			×	46.1							X		
· PRR - Winter Park	1400			23.2									
· PRR - Glenwood Springs	1400			28.7									
Highway Alignment - Electric Power	1200			40.0		4	*//////////////////////////////////////	×/////////////////////////////////////		1			
· LRT - Single · LRT - Double	<u>1320</u> 2640		1	48.6 48.6			¥/////////////////////////////////////		X/////////////////////////////////////				
· AGS - Supported - Double	4200	\////////////////////////////////////	1	<u>40.0</u> 63			¥/////////////////////////////////////	<u> </u>					
· AGS - Suspended - Double	4200	\////////////////////////////////////		63			X/////////////////////////////////////	<u> </u>					
· AGS - Side Hanging - Unit	4200		1	63									
6% Alignment - Diesel Power													
· LRT - Single	1416			45.8	\///////			<u> </u>	1		X		
· LRT - Double	2832		×	45.8			<u> </u>	X/////////////////////////////////////	X/////////////////////////////////////		8		
· HRT - Single	4320			33.3		<u>}</u>		1			X.		
· HRT - Double	8640			33.3		X	<u> </u>	1			8		
· PRR in Corridor - Single		-											
· PRR in Corridor - Double													
6% Alignment - Electric Power													
· LRT - Single	1320			48.4	V///////	/	<i>\////////////////////////////////////</i>	X/////////////////////////////////////	7				
· LRT - Double	2640		,	48.4		1			X/////////////////////////////////////				
· HRT - Single	4200			44.6									
· HRT - Double	4200			44.6]		×			
· PRR in Corridor - Single											-		
· PRR in Corridor - Double			a					4				_	
· AGS - Supported - Double	4200			64.5			X/////////////////////////////////////	1					
· AGS - Suspended - Double	4200		2	64.5			¥/////////////////////////////////////	1	*				
· AGS - Side Hanging - Unit	4200			64.5				1		****	×		
· MUP - Single	4380	[//////////////////////////////////////	1	42.8				1			×		
· MUP - Double	8760			42.8			X/////////////////////////////////////	1	<u> </u>		Ŏ		
4% Alignment - Diesel Power													
· LRT - Single	1416			48.7				<u> </u>	<u>X////////////////////////////////////</u>	1			
· LRT - Double	2832			48.7				X/////////////////////////////////////					
· HRT - Single	4320	<u> </u>		36.4		§	<u> </u>	X/////////////////////////////////////					
· HRT - Double	8610			36.4		8	<u> </u>	\$/////////////////////////////////////					
· PRR in Corridor - Single		-											
· PRR in Corridor - Double													
4% Alignment - Electric Power							1//////////////////////////////////////	·····	· · · · · · · · · · · · · · · · · · ·	1			
· LRT - Single	1320	~~~~~~		50.2			<i>\////////////////////////////////////</i>	X/////////////////////////////////////	<u> </u>	1			
· LRT - Double	2640		8	50.2			¥/////////////////////////////////////	<u> </u>		~			
· HRT - Single	4200	<i>\////////////////////////////////////</i>	1	47.2		1		1		*			
· HRT - Double	4200		1	47.2		1	<u> </u>	1					
PRR in Corridor - Single PRR in Corridor - Double		-											
AGS - Supported - Double	4200	1111111	4	68.3		<u> </u>	*//////////////////////////////////////	1					
· AGS - Supported - Double	4200		1	68.3			<i>₹////////////////////////////////////</i>]					
· AGS - Suspended - Double · AGS - Side Hanging - Unit	4200			68.3			¥/////////////////////////////////////	ļ					
· MUP - Single	4380			45.7	1//////////////////////////////////////		X/////////////////////////////////////	1		x			///////////////////////////////////////
· MUP - Double	8760			45.7	-\////////////////////////////////////			}		х			
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Legend





8-2

I-70 Mountain Corridor PEIS FGT Need, Safety & Implementation Summary

03/20/01

Rubber Tire Transit Alternatives

ernative	es	Need					Safety	Implementation				
		Practical Capacity (Peak Hour)	System Attractiveness	-	rage eed	Connectivity	Feeder/Distribution Requirements	System Safety	Costs	Technology Available	Fuel Usage	Energy Consumption
ES	Direction	Rating		Actual MPH	Rating				CAP.			

RUBBER TIRE TRANSIT ALTERNATIVES Bus/Van in Mixed Traffic or HOV

Lanes (Diesel Only)

· Bus/Van in Mixed Traffic	Both	36				
· Marked Lane	Peak	51				
· Marked Lane	Both	51				
· Separated Lane	Peak	51				
· Separated Lane	Both	51				

Transitway

· Diesel Power	Peak	51	
	Both	51	
· Dual Power (Diesel/Electric)	Peak	60	
	Both	60	
· Electric Power	Both	60	

Guideway (Guided Transitway)

· Diesel Power	Peak	51		
	Both	51		
	BRT Station	54	///////X//////////////////////////////	
· Dual Power (Diesel/Electric)	Peak	60		
	Both	60		
	BRT Station	64		
· Electric Power	Both	60		
	BRT Station	64		

Legend Highest/Best Best to Intermediate Worst to Intermediate Lowest/Worst Image: Structure of the structure of the

DRAFT

I-70 Mountain Corridor PEIS Rubber Tire Transit Need, Safety & Implementation Summary

Highway Alternatives

Need						Safety		Implementation
	olume to Speed Duration of acity Ratio Congested Hours		Accident Reduction	Cost	Constructability			
Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Sections I - J Eisenhower Tunnel to US 40	Sections K - M US 40 to Floyd Hill	Potential		

HIGHWAY ALTERNATIVES

· No Build/2020	1.05/LOS F 1.10/LOS F 29 25 4 5
• Alternative 1 6 Lane Full Width Including TCI with Mixed Barrier Sepatated and Open Median Template	e 0.56/LOS C 0.83/LOS D 65 61 0 0
Alternative 2 6 Lane Full Width Including TCI with Structured Lanes	0.56/LOS C 0.83/LOS D 65 61 0 0 ////////////////////////////////
Alternative 3 6 Lane Reduced Width Including TCI	0.56/LOS C 0.83/LOS D 65 61 0 0 ////////////////////////////////
Alternative 4 6 Lane Reduced Width Including TCI with Structured Lanes	0.56/LOS C 0.83/LOS D 65 61 0 0 ////////////////////////////////
Alternative 5 6 Lane Reduced Width Including TCI with Structured and Tunneled Lanes	0.56/LOS C 0.83/LOS D 65 61 0 0 ////////////////////////////////
· Alternative 6 6 Lane Reduced Width Including TCI with Structured and Cantilevered Lanes	0.56/LOS C 0.83/LOS D 64 61 0 0
Alternative 7 6 Lane Mixed Full and Reduced Width Including TCI	0.56/LOS C 0.83/LOS D 64 61 0 0
Alternative 8 Silverthorne Tunnel	
· Alternative 10 Parallel Routes from East of Twin Tunnels to Approximately Fall River Road	
Alternative 11 6 Lane Reduced Width Including Structured Lanes	1.10/LOS F 0.82/LOS D 45 62 4 0 0
· Alternative 12 6 Lane Reduced Width Including TCI with Movable Median and Structured Lanes	1.10/LOS F 0.82/LOS D 45 62 4 0 0
Alternative 13 6 Lane Reduced Width Including TCI with Flex and Structured Lanes	1.10/LOS F 0.82/LOS D 45 62 4 0
· Alternative 14 6 Lane Reduced Width Including TCI with Reversible and Structured Lanes	1.10/LOS F 0.82/LOS D 45 62 4 0 0

Legend





I-70 Mountain Corridor PEIS Highway Need, Safety & Implementation Summary

	Environmental Sensitivity								Community Values			
Air Quality	Water Quality	Waters of the U.S./ Wetlands	Fish Habitats	Wildlife Habitats and Crossings	Threatened, Endangered and Sensitive Species	Geologic Hazards/ Mining	Noise	Community/ Recreation/ 4(f) and 6(f)	Cultural Resources/ 4(f)	Federal Management and Scenic Features/ Views		

FGT ALTERNATIVES

FGI ALIERNATIVES			Elevated On Grade
· Highway Alignment - Diesel	Please Refer to Energy Requirements		
· Highway Alignment - Electric	Please Refer to Energy Requirements		
· 6% Grade - Diesel	Please Refer to Energy Requirements		
- 6% Grade - Electric	Please Refer to Energy Requirements		

RTT ALTERNATIVES

		Diesei Dudi Liecuit	
· HOV Lanes	Please Refer to Energy Requirements		
· Transit Way	Please Refer to Energy Requirements		
· Guideway	Please Refer to Energy Requirements		

HIGHWAY ALTERNATIVES

· Alternative 1	6 Lane Full Width Including TCI with Mixed Barrier Sepatated and Open Median Template	Under Study			
· Alternative 2	6 Lane Full Width Including TCI with Structured Lanes	Under Study			
• Alternative 3	6 Lane Reduced Width Including TCI	Under Study			
· Alternative 4	6 Lane Reduced Width Including TCI with Structured Lanes	Under Study			
Alternative 5	6 Lane Reduced Width Including TCI with Structured and Tunneled Lanes	Under Study			
· Alternative 6	6 Lane Reduced Width Including TCI with Structured and Cantilevered Lanes	Under Study			
• Alternative 7	6 Lane Mixed Full and Reduced Width Including TCI	Under Study			
Alternative 8	Silverthorne Tunnel	Under Study			
Alternative 10	Parallel Routes from East of Twin Tunnels to Approximately Fall River Road	Under Study			
Alternative 11	6 Lane Reduced Width Including Structured Lanes	Under Study			\//////////////////////////////////////
Alternative 12	6 Lane Reduced Width Including TCI with Movable Median and Structured Lanes	Under Study			
Alternative 13	6 Lane Reduced Width Including TCI with Flex and Structured Lanes	Under Study			
Alternative 14	6 Lane Reduced Width Including TCI with Reversible and Structured Lanes	Under Study		///////////////////////////////////////	

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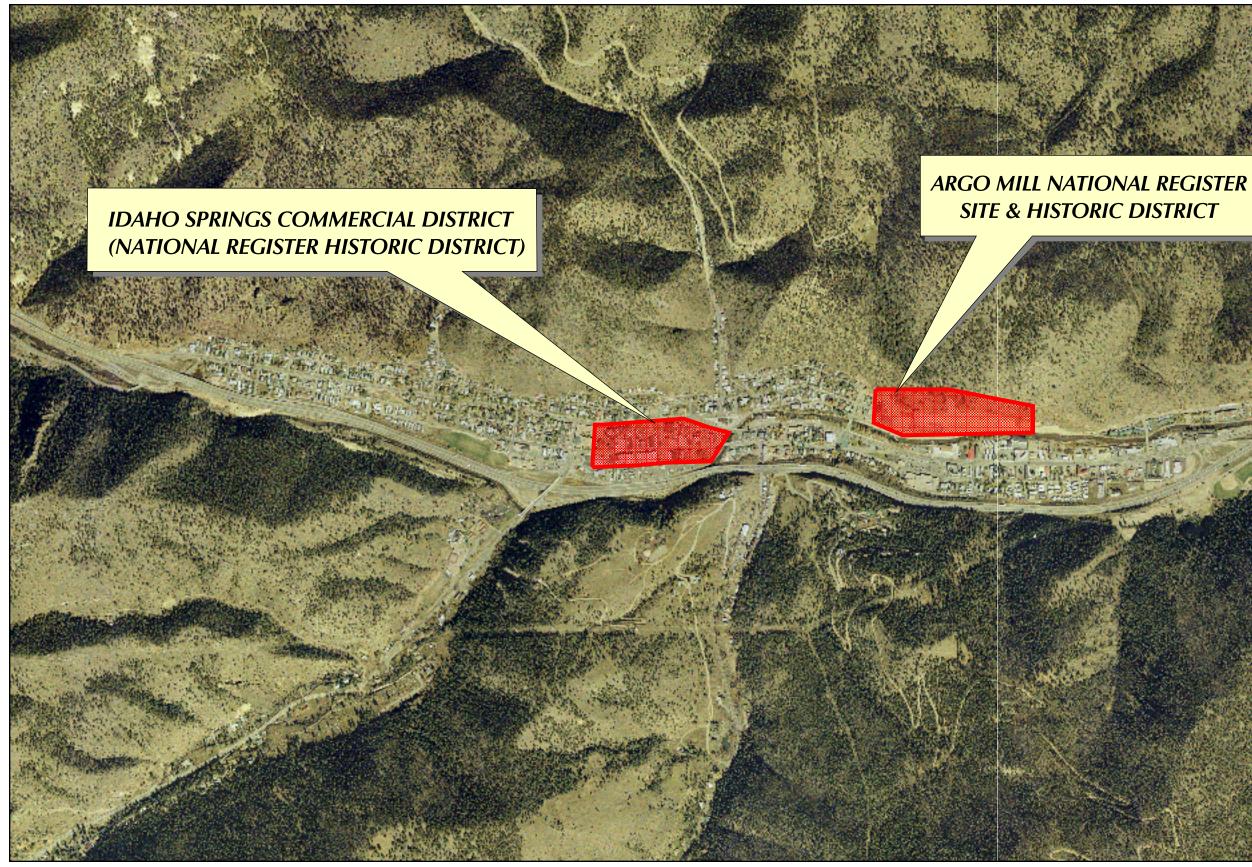
Level of Conflict

Greatest Potential for Conflict	Greatest - Intermediate Potential for Conflict	Intermediate Potential for Conflict	Intermediate - Least Potential for Conflict	Least Potential for Conflict

Diesel Dual Electric

I-70 Mountain Corridor PEIS Environmental Resource Summary

9 – NATIONAL HISTORIC DISTRICT AREAS







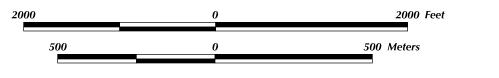
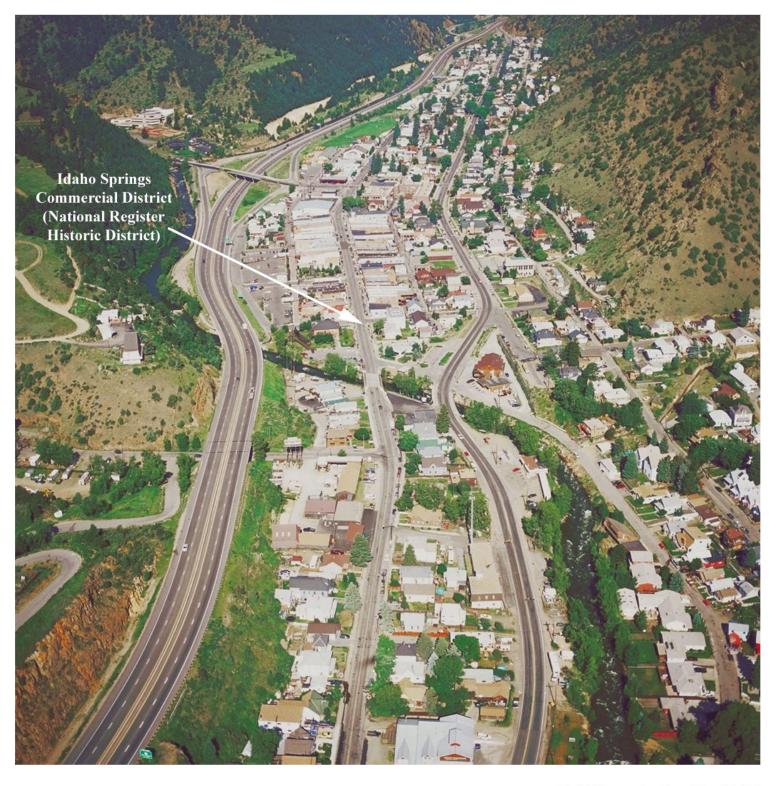


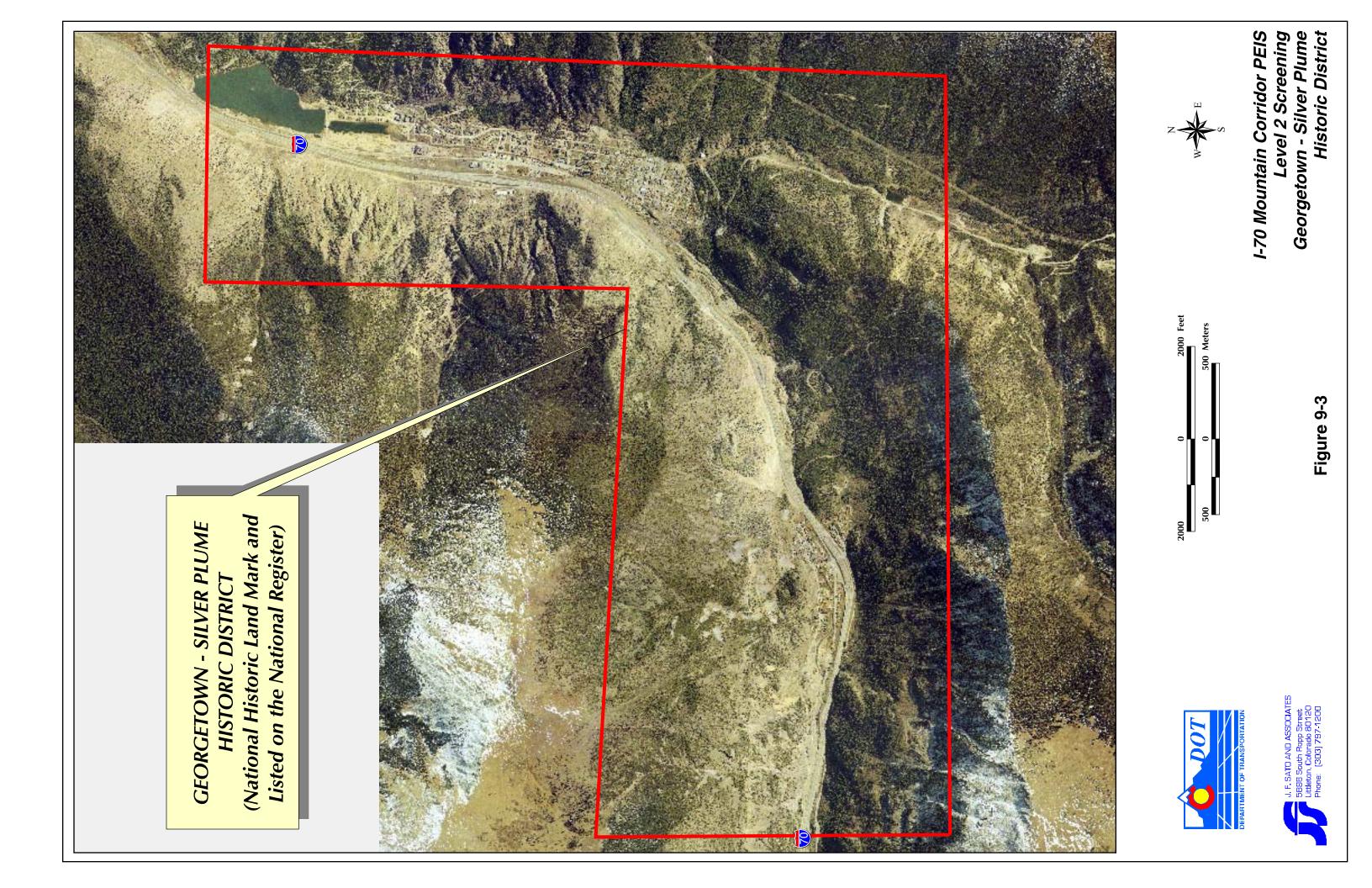
Figure 9-1

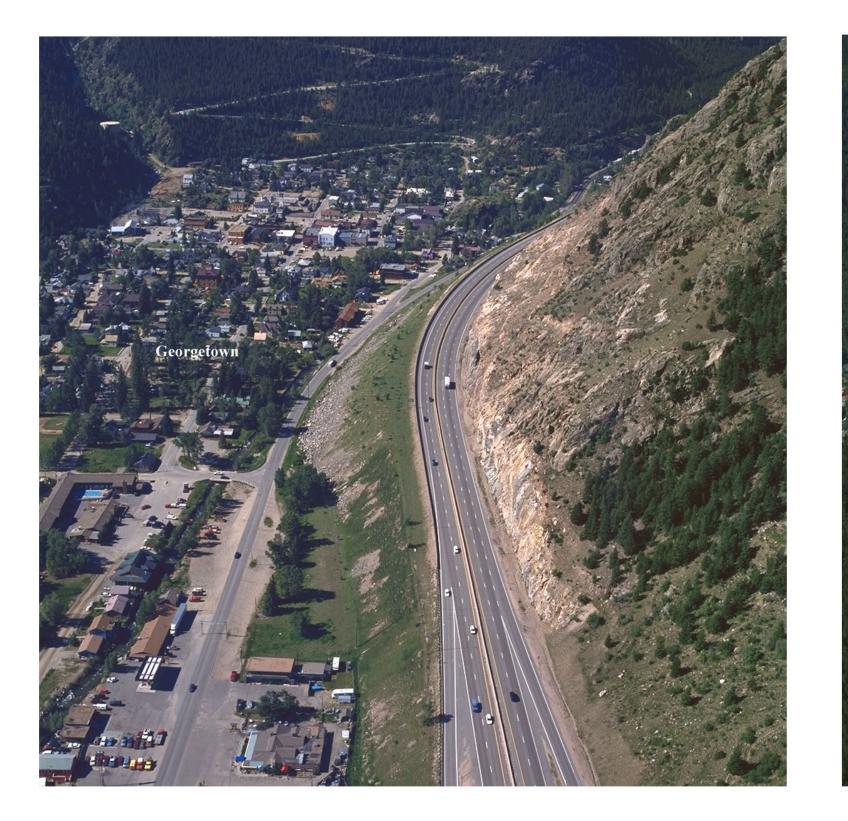
I-70 Mountain Corridor PEIS Level 2 Screening Idaho Springs **Historic Districts**





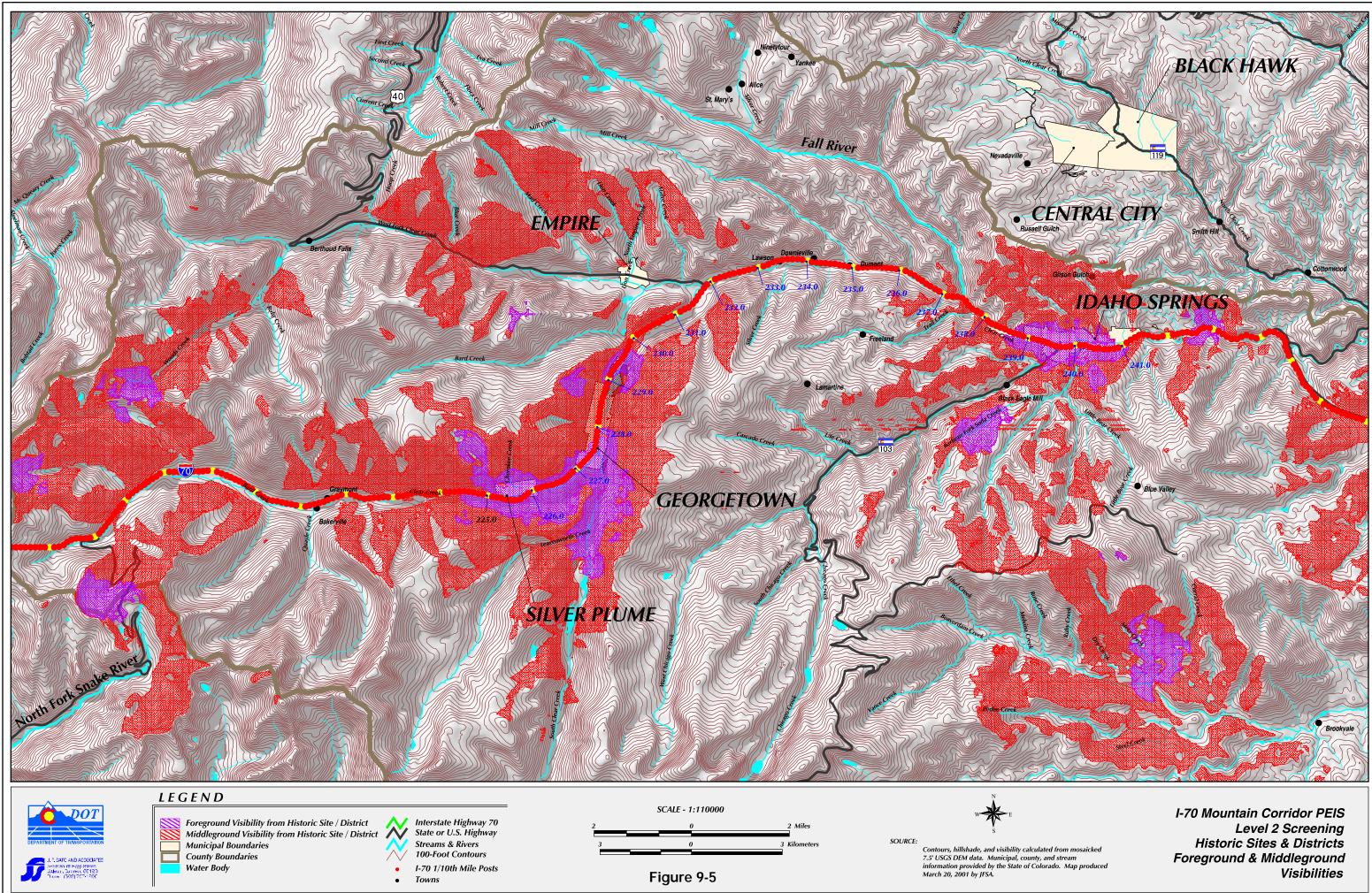
I-70 Mountain Corridor PEIS Level 2 Screening Idaho Springs Historic Districts View West







I-70 Mountain Corridor PEIS Level 2 Screening Georgetown & Silver Plume Historic District (National Historic Landmark, Listed on the National Register)



Appendix G TranSystems I-70 Mountain Corridor Air Service Characteristics and Operational Inventory July 2000 This page intentionally left blank.

Figure 1.10Figure 1.10Air Service Characteristics &
Operational Inventory

Prepared for:

Colorado Department of Transportation



J.F. Sato & Associates, Inc.

Prepared by:



July 2000

I-70 MOUNTAIN CORRIDOR PROGRAMMATIC EIS: Air Service Characteristics & Operational Inventory

DRAFT FINAL REPORT

Prepared For: J. F. Sato & Associates

Prepared By:



July 26, 2000

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Garfield County Regional Airport (RIL)	20
Glenwood Springs Municipal Airport (GWS)	20
Kremmling Airport (20V)	20
Lake County Airport (LXV)	21
Steamboat Springs/Bob Adams Field (SBS)	21
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Executive Summary

Purpose

The purpose of developing an inventory of aviation service in the I-70 mountain corridor is to gain an understanding of the role that aviation plays in meeting the mobility needs of travelers in the corridor. The inventory also will be used to assess the role that aviation might play in meeting future travel demand in the corridor.

Mountain Corridor Airports

There are nine airports in the I-70 mountain corridor. Five of them are general aviation facilities and four are primary commercial service airports. The latter is distinguished from the former by its scheduled air carrier service and aircraft capacity. General aviation facilities generally have lesser aircraft capacity and are used for air activities such as recreational flyers and private charter and air taxi operators.

Air Service Activity

Over the past eight years, passenger enplanement activity at the four primary airports has increased for all of the airports except Walker Field (GJT), which has seen considerable fluctuations. Eagle County Regional Airport (EGE) has seen the greatest annual growth among the four airports, with Aspen-Pitkin County (ASE) and Yampa Valley (HDN) experiencing steady growth from year to year.

Despite the relatively year-round stability of EGE and GJT, air service activity in the I-70 mountain corridor remains largely driven by the winter ski season. For example, fare subsidies or revenue guarantees offered by the resort communities to entice air passengers and ensure airlines continue otherwise unprofitable routes, have considerable impact on the enplanements of the four airports. For example, without seat guarantees, annual enplanement projections for 2020 drop by as much as 30,000 seats for HDN. By way of another example, decreased enplanements at GJT coincide with increased fare subsidies at ASE and HDN in the same years.

Airport Operational Characteristics

Aspen-Pitkin County Airport is served by three airlines with nearly 200 flights per week during the winter season. It is located three miles northwest of Aspen and seven miles southeast of Snowmass Village along Colorado Highway 82. The elevation at which the airport is sited is approximately 7,800 feet. Passenger enplanements at ASE have increased steadily in the last eight years although enplanements fell from a peak of 252,025 in 1993 to 203,782 in 1995. (Enplanements were at 206,041 in 1991.) However, passenger activity climbed again to 249,651 by 1998.

Eagle County Regional Airport is just off I-70 in the western part of Eagle County, four miles west of Eagle. The airport is sited at an elevation of 6,500 feet. There are a limited number of flights (mainly in the ski season) each day to and from some of the larger U.S. cities operated by five commercial carriers. Prior to 1990, the airport did not have commercial air service. Since then, growth in passenger enplanements has been substantial. Beginning with slightly more than 30,000 enplanements in 1991, there has been a 465% increase to 171,272 enplanements reported



for 1998. EGE has seen significant increases from year to year in passenger enplanements, leaping approximately 20,000 each year from 1992 to 1995; 30,000 enplanements between 1995 and 1996; and 51,000 enplanements between 1996 and 1997. In the late 90s, a \$9-million passenger terminal was built to accommodate this air passenger growth.

Grand Junction's Walker Field has the most highly developed and modern airfield facilities between Denver and Salt Lake City. Located in western Colorado, it is considered to be a premier airport serving western Colorado and eastern Utah. Walker Field is located three miles northeast of the city at a 4,800 ft. elevation. Located one mile from I-70, Walker Field hosts three commercial carriers with over 18 year-round daily departures to Denver, Phoenix and Salt Lake City. In the last eight years, enplanements at GJT peaked in 1993 at 151,695 and fell as low as 125,411 in 1995. Average annual enplanements over the same period hovered at 136,000.

Yampa Valley Regional Airport is owned and operated by Routt County, Colorado. It is situated at an elevation of 6,600 ft., two miles southeast of the town of Hayden. Near the Steamboat Springs ski resort, it is host to three major airlines during the ski season (mid-December through March) with direct service from Chicago, Dallas/Ft. Worth, Houston, Newark, Atlanta/St. Louis, Los Angeles and Denver. Commuter service is provided year-round to Denver by United Express. Enplanements have climbed steadily since 1991 (59,129) with a slight dip of 3,000 fewer enplanements in 1992. Nevertheless, passenger activity has climbed since 1992 increasing by 34% between 1994 and 1995 alone. HDN reports that 90% of their enplanements take place during the four-month winter ski season.

Air Activity Trends

Compared with national data, enplanement projections for regional airports (such as ASE, EGE, GJT and HDN) are forecast to increase at an annual rate of 5.5% between 1998 and 2009. Enplanements are forecast to slow to 3.6% between 2010 and 2020. Each of the primary airports in the mountain corridor projects steady increases in enplanements through 2020. General aviation facilities will be greatly improved by advances in air system technology and demand will outstrip supply. Other trends that are expected to impact air activity service in the mountain corridor are summarized as follows:

• Airline fleet changeovers from propeller driven aircraft to regional jet aircraft will boost aircraft capacity, serve greater markets, and attract air passengers previously unwilling to travel in propeller aircraft.

• Advances in national air system technology will "grow" the capacity of primary and general aviation facilities.

• Greater pressure will be placed on summer recreational industries to help bear the costs of revenue guarantees and even-out the seasonal vagaries of air activity.

• In the absence of greater marketing efforts, declines in out-of-state skiers and greater reliance on Front Range skiers are expected.

• With continued economic growth and aging Baby Boomer population, increased second-home development is expected.



Hub Access Airports

Colorado's major hub airports, Denver International Airport (DEN) and Colorado Springs Airport (COS) serve as gateway facilities to the mountain airports. At DEN, 100 nonstop domestic destinations and 10 nonstop international destinations are available from the airport, including service to the four mountain corridor airports. Numerous charter and scheduled sharedride transportation is available from DIA to the mountain resorts. At COS, twelve nonstop destinations are available from the airport, however none of those include the four mountain corridor airports. COS passengers seeking access to the mountain resorts by air, must take connecting flights at DIA. Presently, there are no scheduled shared-ride ground transportation services available from COS to the mountain resorts. Charter services, such as Timberline Express, are available, however.

General Aviation Activity

General aviation activity includes everything from single-engine propeller-driven aircraft to sophisticated corporate jets. General aviation airports in the mountain corridor include Garfield County Regional Airport, Glenwood Springs Municipal Airport, Kremmling Airport (formerly McElroy Airfield), Lake County Airport, and Steamboat Springs/Bob Adams Field. These airports have critical significance to a region even when shared with a primary airport as they transport cargo and provide air ambulances services and charter and aircraft rental.

Air Cargo

Air cargo is typically transported in the baggage compartments of scheduled passenger aircraft and by all-cargo aircraft. Most all-cargo flights are scheduled during off-peak periods and do not substantially contribute to airport congestion and delay problems. Historically, air cargo service has not substituted in any significant way for freight shipping by truck to the communities and airports in the mountain corridor. However, just-in-time logistics will require that producers receive and ship smaller quantities more frequently and quickly over long distances. Air cargo, once considered a luxury and reserved for small, lightweight, compact products with high valueto-weight ratios, is predicted to triple in the next 20 years for some airports.



Introduction

There are nine airports in the I-70 mountain corridor. Five of them are general aviation facilities and four are primary commercial service airports. The latter is distinguished from the former by its scheduled air carrier service and aircraft capacity. General aviation facilities generally have lesser aircraft capacity and are used for air activities such as recreational flyers and private charter and air taxi operators. The Federal Aviation Administration (FAA) also defines commercial service airports as airports with at least 2,500 annual enplanements. Those with fewer enplanements are considered general aviation airports. Commercial service airports with greater than 10,000 annual enplanements are considered primary airports.

Purpose and Scope

The purpose of developing an inventory of aviation service in the I-70 mountain corridor is to gain an understanding of the role that aviation plays in meeting the mobility needs of travelers in the corridor. The inventory also will be used to assess the role that aviation might play in meeting future travel demand in the corridor. The scope of the current analysis includes aviation facilities that serve the I-70 corridor and air transportation services that link air passengers to their ultimate destinations within the mountain corridor "area of influence."

Methodology

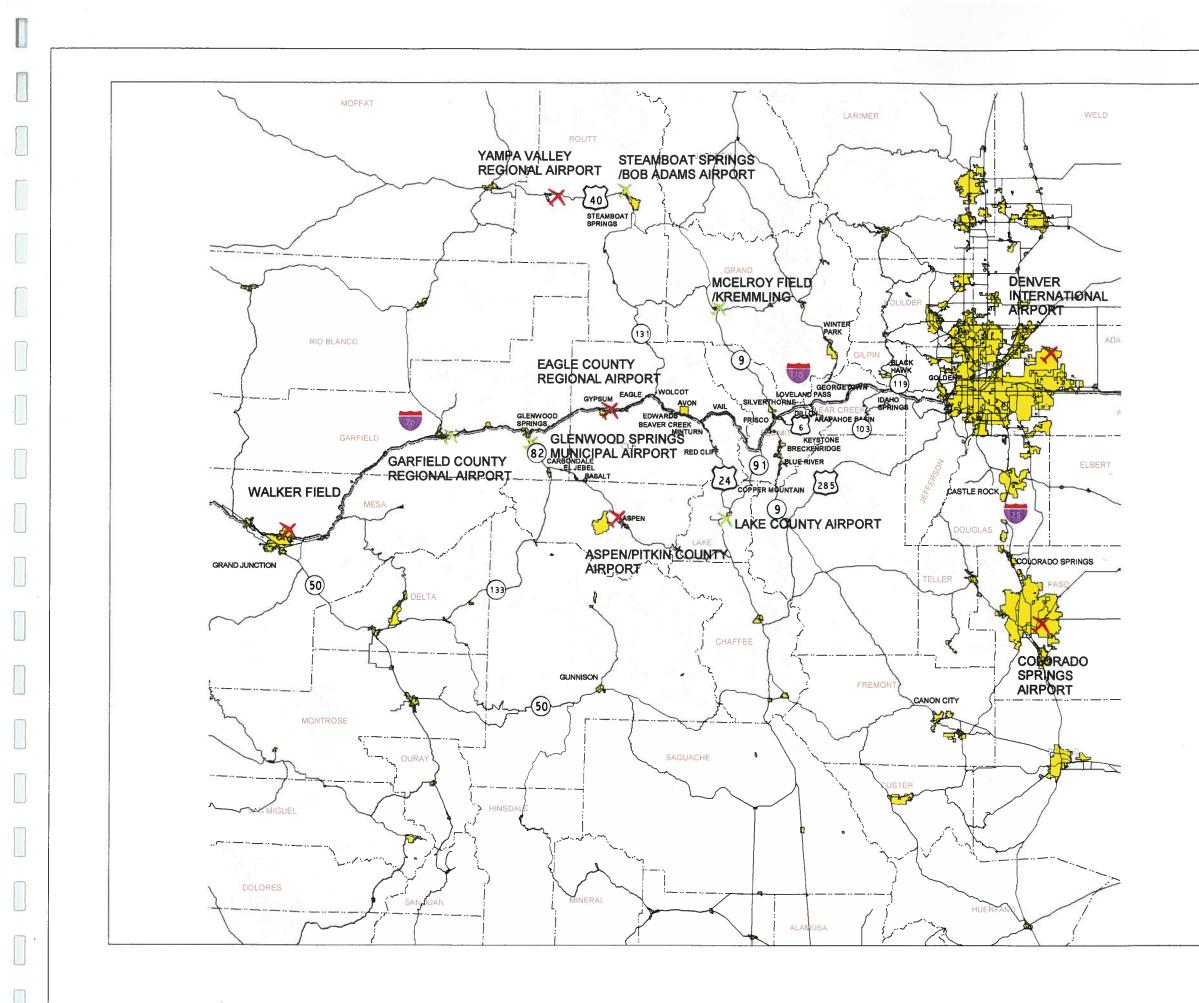
For purposes of inventorying air service in the I-70 mountain corridor, the research focused on commercial service airports, however some anecdotal information about the general aviation facilities is included. Efforts to expand general aviation facilities to augment commercial air service in the mountain corridor recently have been unsuccessful due to extremes posed by weather, terrain and public objections. However, their value to the corridor's air service activity and potential to augment air service should not be dismissed. Please reference the map on the following page.

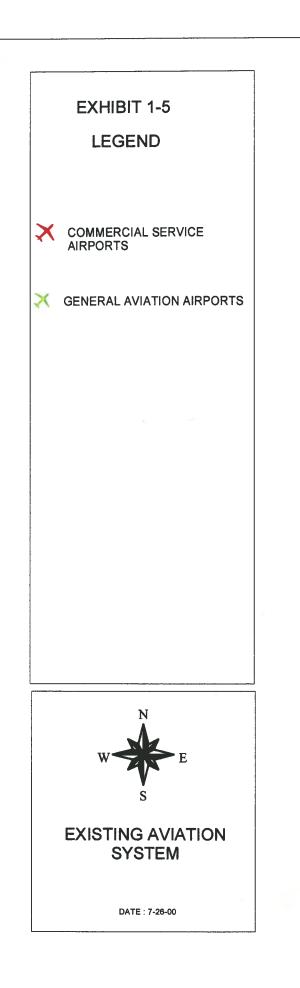
Commercial Aviation

The four principal commercial airports in the I-70 corridor were selected based on their proximity and access to I-70. These include Aspen-Pitkin County/Sardy Field (ASE) in Aspen, Eagle County Regional Airport (EGE) in the Avon/Beaver Creek area, Walker Field (GJT) in Grand Junction, and Yampa Valley Regional Airport (HDN) near Steamboat Springs.

Airport data for commercial airports are largely derived from counts of air passenger enplanements, or the number of passengers boarding an aircraft. This is the standard number by which airport passenger activity is compared. Aircraft operations, such as the percentages of types of air activity (commercial flights, air taxis, military) at the airport, also are included in these data. For purposes of the PEIS, historical, current and forecast data regarding enplanements were used to assess the current capacity of air service and to determine future airport needs. Additional information was gathered regarding each airport's infrastructure such as runway type and capacity, approach type, size of aircraft accommodated, hangar facilities, type of air traffic control, and terminal features. Information regarding seasonal variations and ratios of residential use was used to supplement the passenger data. Descriptions of the airline carriers serving each airport also were included such as type of aircraft, schedules, and flights.







This information was collected from a variety of sources including the airports' aviation directors, the airports' websites, and annual reports of the Federal Aviation Administration's Aviation Capacity Branch.

Results

All of the contacted airport managers at both the commercial service and the general aviation airports responded with the exception of Aspen-Pitkin County/Sardy Field. Several attempts were made to reach the manager and assistant manager, but they did not respond. Calls were placed to the county facilities manager, but that person also did not respond.

Findings

Air Service Activity

Airport activity data for commercial service airports are based on air passenger enplanements; that is, the number of passengers boarding the aircraft. Current and forecast passenger enplanement data and aircraft operations are the basis for determining future airport needs.

Over the past eight years, passenger enplanement activity at the four primary airports has increased for all of the airports except Walker Field (GJT), which has seen considerable fluctuations. Eagle County Regional Airport (EGE) has seen the greatest annual growth among the four airports, with Aspen-Pitkin County (ASE) and Yampa Valley (HDN) experiencing steady growth from year to year.

Alrport	Histor Enplane		Historical Annual Growth Rate	Proje Enplane		Projected Annual Growth Rate	Seasonal Variation	Residential To Translent Ratio
	1991	1998		2010	2020			
ASE	206,041	249,651	2.80%	Data not supplied	DNS	DNS	Winter, 50%	DNS
EGE	30,308	171,272	58%	200,000*	260,000*	5%	Winter, 70%	27%
GJT	133,735	129,697	-0.38%	264,000	299,800*	2.3%	May-Oct, Slight1	30-40%
HDN	59,129	106,092	10%	128,800*	188,200	2.9%	Winter, 90%	N/a

Table 1.1 Passenger Enplanement Activity at the Four Primary Airports

Source: FAA DOT/TSC CY1998 ACAIS Database, Airport Managers

* Projections for EGE are 2001 and 2006; Projections for GJT are 2010 and 2015; Projections for HDN are 2005 and 2020

Compared with national data, enplanement projections for regional airports (such as ASE, EGE, GJT and HDN) are forecast to increase at an annual rate of 5.5% between 1998 and 2009. Enplanements are forecast to slow to 3.6% between 2010 and 2020.

Despite the relatively year-round stability of EGE and GJT, air service activity in the I-70 mountain corridor remains largely driven by the winter ski season. For example, fare subsidies or revenue guarantees offered by the resort communities to entice air passengers and ensure airlines continue otherwise unprofitable routes, have considerable impact on the enplanements of the four airports. For example, without seat guarantees, annual enplanement projections for 2020 drop by as much as 30,000 seats for HDN. By way of another example, decreased enplanements at GJT coincide with increased fare subsidies at ASE and HDN in the same years.



Nevertheless, airlines at two of the primary airports, GJT and EGE, function without revenue guarantees and are well-served by the airlines. GJT and EGE both enjoy year-round air activity with one of GJT's airlines actually stepping up service in the summer months. ASE and HDN continue to rely on revenue guarantees to maintain desired levels of skier activity and airline service. EGE still experiences drop-offs in enplanements after the ski season, but nothing compared to the sharp drop-offs experienced by ASE and HDN.

The four airports also differ in the types of aircraft serving the airport. For example, ASE and HDN predominantly are served by airlines with small (20-30 passenger), propeller- or turbofandriven aircraft such as the BAE 146, DH 8 (or Dash Abouts), Dornier 328, and Beechcraft 1900. Airlines serving EGE and GJT also use these types of aircraft but increasingly are accommodating regional jet aircraft that hold 50-80 passengers and are jet-powered. These jet aircraft, also dubbed RJs or mini-757s, provide numerous air flight efficiencies and benefits, not the least of which is greater passenger confidence.

With regard to weather and terrain, these mountain airports are subject to greater hazards and limitations than most airports. Advances in aviation technology are predicted to minimize some of these hazards and limitations (see the Aviation Alternatives Report), but it is important to note that, currently, severe weather contributes to significant flight delays. For example, 38% of arrivals to EGE, occur on-time, and 78% of departures occur on-time. At HDN, 78% of arrivals occur on-time, and 89% of departures occur on-time. Airports in Barrow and Dutch Harbor, Alaska, Jackson, Wyoming, and Monterey, California experience similar delays due to constraints of weather and terrain. Otherwise, these percentages are markedly below larger airport on-time percentages.



Airport characteristics and operational data

Each of the four airports serving the I-70 corridor has vastly differing characteristics that affect its air service market and frequency of service as shown in Table 1.2.

Percentage of Aircraft Operations						
	Commercial	Transient GA	Air Taxi	Local GA	Military	Total Avg/Day
ASE	24%	57%	10%	9%	<1%	125
EGE	21%	48%	5%	15%	11%	88
GJT	13%	39%	20%	25%	3%	238
HDN	44%	42%	3%	11%	<1%	23

Table 1.2 Percentage of Aircraft Operations at the Four Primary Airports
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Source: Airport AirNav web sites

The general characteristics of each airport are described below with current operation levels and activity forecasts. Fare information for airlines serving each airport is intended to provide a frame of reference to compare prices (some of which may reflect seat subsidies) but readers should be aware that numerous fare specials are offered and fares cited in this report can be substantially lower or higher.

Aspen-Pitkin County Airport (ASE)

Aspen-Pitkin County Airport is served by three airlines with nearly 200 flights per week during the winter season. It is located three miles northwest of Aspen and seven miles southeast of Snowmass Village along Colorado Highway 82. The elevation at which the airport is sited is approximately 7,800 feet.



F.1. Aspen-Pitkin County Airport/Sardy Field

Passenger enplanements at ASE have increased steadily in the last eight years although enplanements fell from a peak of 252,025 in 1993 to 203,782 in 1995. (Enplanements were at 206,041 in 1991.) However, passenger activity climbed again to 249,651 by 1998.



Table 1.3 below summarizes ASE's enplanement data over an eight-year period, projected enplanements, as well as seasonal variations and the rate of residential use.

		DUNTY/S		LD (ASE))		
Historical Enplanements		Historical Annual Growth Rate	Historical Projected Enplanements Annual Growth		Projected Annual Growth Rate	Seasonal Variation	Residential Use Ratio
1991	1998					Winter	
206,041	249,651	2.80%	Data not supplied (DNS)	DNS	DNS	50%	DNS

Toble 1.2 ACE Englement Activity

Source: FAA DOT/TSC CY1998 ACAIS Database

ASE has two runways each 7,000 feet long and 100 feet wide. They are composed of asphalt and can accommodate from 80,000 pounds of single-axle weight to 160,000 pounds of doubletandem weight. Over 100 aircraft are based on the field and the air traffic control tower is staffed from 7:00am to 11:00pm. On average, ASE handles 125 flights per day with nearly 25% of those flights being commercial air service. Improvements include upgrades to the general aviation facilities.

Infrastructure features are summarized in Table 1.4 below.

Table 1 4 ASE Infrastructure Features

ASPEN-PI	TKIN COUNTY/SARDY FIELD (ASE)
Type of Airport (primary, GA, military, reliever):	Primary
Runway Info (length, width, capacity):	Two runways; Dimensions: 7004 x 100 ft.; Surface: asphalt/porous friction courses, in good condition; Weight limitations: PCN 26/F/C/X/T Single wheel: 80000 lbs Double wheel: 100000 lbs Double tandem: 160000 lbs
Approach Type (VFR, IFR*):	IFR
Based Aircraft:	Aircraft based on the field: 103; Single engine airplanes: 80; Multi engine airplanes: 11; Jet airplanes: 7; Gilders: 5
Hangar Facilities:	Hangars and tiedowns
Airport Operations:	Aircraft operations: average 125/day; 57% transient general aviation; 24% commercial; 10% air taxi; 9% local general aviation; <1% military
Air Traffic Control:	Attended 7am to 11pm
Terminal Features	45,000 SF, five rental car agencies, one restaurant, two vending machine companies, one gift shop, two ground transportation booths, two small baggage carousels (one exclusively for UA)

*VFR stands for visual flight rules and is typically the case for general aviation facilities. IFR stands for instrument flight rules and is typically the case for commercial service facilities. IFR differs from VFR in that non-precision instruments (or VFR) may be required during periods of extreme weather.

Source: AirNav Aspen-Pitkin County/Sardy Field Web Site

Airlines with direct service into ASE include the following:

Northwest Airlines offers two daily nonstop flights from Minneapolis/St. Paul, using RJ-85 jet aircraft, during the ski season. Round-trip fares are over \$1,000 during the ski season for the least-expensive alternative. Northwest's global alliance with KLM Royal Dutch Airlines allows seamless two-stop connections from dozens of cities throughout Europe via their Amsterdam hub. No flights are offered in the shoulder seasons, but in the summer season, one nonstop is offered from MSP on BAE 146 aircraft.

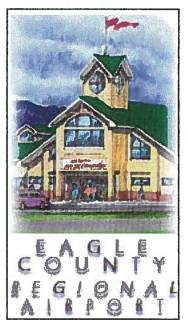
United Airlines offers two daily one-stop flights (via Denver) from Los Angeles, with service on BAE-146 jet aircraft, and five daily nonstop flights from Denver during the ski season. There are

numerous two-stop connections from most major international airports such as Dulles, Chicago, Newark, San Francisco, and Miami. Round-trip fares during the ski season from Denver are about \$288 round-trip and flights from LAX are about \$532 round-trip for the least-expensive alternatives. Flights are reduced considerably during the shoulder season but five flights are offered from Denver June through September on United Express/Wisconsin Air.

America West offers two daily nonstop flights from Phoenix on 37-passenger Dash-8-200 (DH8) aircraft during the ski season. This service also provides one-stop access, with a layover on the arrival, via British Airways nonstop from London/Gatwick. Round-trip fares during the ski season from Phoenix are about \$380 for the least-expensive alternative. During the summer season, three daily nonstops are offered from Phoenix.

Eagle County Regional Airport (EGE)

Eagle County Regional Airport is just off I-70 in the western part of Eagle County, four miles west of Eagle. The airport is sited at



F.2. Eagle County Regional Airport

an elevation of 6,500 feet. There are a limited number of flights (mainly in the ski season) each day to and from some of the larger U.S. cities operated by five commercial carriers.

Prior to 1990, the airport did not have commercial air service. Since then, growth in passenger enplanements has been substantial. Beginning with slightly more than 30,000 enplanements in 1991, there has been a 465% increase to 171,272 enplanements reported for 1998. EGE has seen significant increases from year to year in passenger enplanements, leaping approximately 20,000 each year from 1992 to 1995; 30,000 enplanements between 1995 and 1996; and 51,000 enplanements between 1996 and 1997. In the late 90s, a \$9 million passenger terminal was built to accommodate this air passenger growth.



Table 1.5 below summarizes EGE's enplanement data over an eight-year period, projected enplanements, as well as seasonal variations and the rate of residential use.

Table 1.5	EGE Er	planement	t Activity

EAGLE COUNTY REGIONAL AIRPORT (EGE)							
Historical Enplanements		Historical Annuai Growth Rate	Projected Enj	planements	Projected Annual Growth Rate	Seasonal Variation	Residentiai Use Ratio
1991	1998		2001	2006		Winter	
30,308	171,272	58%	200,000	260,000	5%	70%	27%

Source: FAA DOT/TSC CY1998 ACAIS Database, EGE Airport Manager

EGE has two runways each 8,000 feet long and 150 feet wide. They are composed of grooved asphalt and can accommodate from 60,000 pounds of single-wheel weight to 115,000 pounds of double-wheel weight. Over 50 aircraft are based on the field and the air traffic control tower is staffed from 7:00am to 7:00pm. On average, EGE handles 88 flights per day with 21% of those flights being commercial air service. EGE is planning to extend Runway 7/25 by 1,000 feet to the east. No other major capital improvements are planned.

Infrastructure features are summarized in Table 1.6 below.

Table 1.6 EGE Infrastructure Features

Primary
Two runways; Dimensions: 8000 x 150 ft.; Surface: asphalt/grooved, in good condition; Weight limitations: Single wheel: 60000 lbs, Double wheel: 115000 lbs
IFR
Aircraft based on the field: 51; Single engine airplanes: 28; Multi-engine airplanes: 4; Jet airplanes: 10; Military: 9
Hangars and tiedowns
Aircraft operations: average 88/day; 48% transient general aviation; 21% commercial; 15% local general aviation; 11% military; 5% air taxi
Attended 7am to 9 pm
Two terminals; terminal A is 31,000 SF, Terminal B is 30,000 SF; various concessions; all major rental car agencies

Source: AirNav Eagle County Regional Airport Web Site, EGE Airport Manager



Air service is provided mainly in the ski season by five major carriers with nine daily nonstop flights from U.S. cities, plus eight daily nonstops from Denver, December through March.

American Airlines offers five daily nonstop flights from Chicago, Dallas/Fort Worth, and Newark, December through April. Additional, but limited, flights are offered on weekends only from Miami, New York/LaGuardia with San Francisco service Monday through Wednesday only. American Airlines primarily uses 757 aircraft. Round-trip fares from Chicago during the ski season are about \$1,418 for the least-expensive alternative. Round-trip fares from DFW during the ski season are about \$1,224 for the least-expensive alternative. Round-trip fares from Newark during the ski season are about \$1,660 for the least-expensive alternative.

Continental Airlines offers one daily nonstop from Houston (IAH) December through April, and two Saturday nonstop flights from Newark, December through April. Continental primarily uses 757 aircraft. Round-trip fares from Houston during the ski season are about \$1,300 for the least-expensive alternative.

Delta Airlines offers one daily nonstop from Atlanta, December through March. Delta primarily uses 757 aircraft. Delta has no scheduled flights into EGE for the 2000-2001 ski season.

Northwest Airlines offers one daily nonstop from Minneapolis/St. Paul, December through April. An additional nonstop weekend flight is offered from MSP, February through April. One Saturday nonstop flight is offered from Detroit, December through April. Northwest primarily uses 757 aircraft. Round-trip fares from Houston during the ski season are about \$990 for the least-expensive alternative.



F.3. Airlines Serving Eagle County Regional Airport United Airlines offers nonstop service from Chicago, New York, Los Angeles, and Denver. One weekend nonstop flight is offered from Chicago or New York, December through April. There are eight daily flights from Denver (United Express/Great Lakes Aviation) and one daily flight from Los Angeles, December through April. Year-round, United Airlines (United Express) offers seven daily nonstop flights to Denver. United Airlines primarily uses BAE 146 and Beechcraft 1900 aircraft. Round-trip fares from Chicago during the ski season are about \$1,410 for the least-expensive alternative. Round-trip fares from New

York during the ski season are about \$1,750 for the least-expensive alternative. Round-trip fares from LAX during the ski season are about

\$586 for the least-expensive alternative.

Grand Junction-Walker Field (GJT)

Grand Junction's Walker Field has the most highly developed and modern airfield facilities between Denver and Salt Lake City. Located in western Colorado, it is considered to be a premier airport serving western Colorado and eastern Utah. Walker Field is located three miles northeast of the city at a 4,800 ft. elevation. Located one mile from I-70, Walker Field hosts three commercial carriers with over 18 year-round daily departures to Denver, Phoenix and Salt Lake City



In the last eight years, enplanements at GJT peaked in 1993 at 151,695 and fell as low as 125,411 in 1995. Average annual enplanements over the same period hovered at 136,000.

Table 1.7 below summarizes GJT's enplanement data over an eight-year period, projected enplanements, as well as seasonal variations and the rate of residential use.

Table	1.7	GJT	Enplanement Activity

WALKER	FIELD (GJT)					
Historical Enplanements		Historical Annual Growth Rate	Projected En	olanements	Projected Annual Growth Rate	Seasonal Variation	Residential Use Ratio
1991	1998		2010	2015		May-Oct	
133,735	129,697	-0.38%	264,000	299,800	2.3%	Slight ↑	30-40%

Source: FAA DOT/TSC CY1998 ACAIS Database, Walker Field Public Communications Director

GJT's two main runways are 10,500 feet long and 150 feet wide with 20-foot-wide paved shoulders. The other two runways are cross-wind runways that are 5,500 feet long and 75 feet wide. All runways feature parallel taxiways. They are composed of grooved asphalt. Over 120 aircraft are based on the field and the air traffic control tower is staffed around-the-clock. On average, GJT handles 238 flights per day with 13% of those flights being commercial air service. Walker Field is not planning any major capital improvements.

Infrastructure features are summarized in Table 1.8 below.

Table 1.8 GJT Infrastructure Features WALKER FIELD (GJT)

Type of Airport (primary, GA, military, reliever):	Primary
Runway Info (length, width, capacity):	<i>Two runways</i> ; Dimensions: 5502 x 75 ft.; Surface: asphalt/grooved, in good condition; Weight limitations: PCN 09/F/C/Z/T, Single wheel: 26000 lbs, Double wheel: 26000 lbs <i>Two runways</i> ; Dimensions: 10501 x 150 ft.; Surface: asphalt/porous friction courses, in good condition; Weight limitations: PCN 54/F/C/X/T, Single wheel: 110000 lbs, Double wheel: 180000 lbs, Double tandem: 260000 lbs
Approach Type (VFR, IFR):	IFR
Based Aircraft:	Aircraft based on the field: 126; Single engine airplanes: 105; Multi engine airplanes: 19; Jet airplanes: 2
Hangar Facilities:	Hangars and tiedowns
Alrport Operations:	Aircraft operations: average 238/day; 39% transient general aviation; 25% local general aviation; 20% air taxi; 13% commercial; 3% military
Air Traffic Control:	Continuous
Terminal Features	70,000 sq ft terminal with restaurant, espresso bar and gift shop; six major rental car companies

Source: AirNay Walker Field Web Site



Three major carriers serving GJT year-round include the following:

United Express/Air Wisconsin offers 10 nonstop daily flights from Denver on Dornier 328 and BAE 146 aircraft. Round-trip fares from Denver during the ski season are \$304 for the least-expensive alternative.

Skywest/Delta offers four nonstop daily flights from Salt Lake City using DH8 aircraft. Roundtrip fares from Salt Lake City during the ski season are \$267 for the least-expensive alternative.

American West/Mesa Airlines offers four nonstop daily flights from Phoenix on DH 8 aircraft. Round-trip fares from Phoenix during the ski season are \$329 for the least-expensive alternative.

Yampa Valley Regional Airport (HDN)

Yampa Valley Regional Airport is owned and operated by Routt County, Colorado. It is situated at an elevation of 6,600 ft., two miles southeast of the town of Hayden. Near the Steamboat Springs ski resort, it is host to three major airlines during the ski season (mid-December through March) with direct service from Chicago, Dallas/Ft. Worth, Houston, Newark, Atlanta/St. Louis, Los Angeles and Denver. Commuter service is provided year-round to Denver by United Express.

Enplanements have climbed steadily since 1991 (59,129) with a slight dip of 3,000 fewer



F.4. Walker Field Airport in Grand Junction

enplanements in 1992. Nevertheless, passenger activity has climbed since 1992 increasing by 34% between 1994 and 1995 alone. HDN reports that 90% of their enplanements take place during the four-month winter ski season.

Table 1.9 below summarizes HDN's enplanement data over an eight-year period, projected enplanements, as well as seasonal variations and the rate of residential use.



YAMPA V	ALLEY F	REGIONA	L AIRPOR	T (HDN)			
Historical Enj	planements	Historical Annual Growth Rate	Projected Enp	planements	Projected Annual Growth Rate	Seasonal Variation	Residential Use Ratio
1991	1998		2005	2020		Winter	
59.129	106.092	10%	128.800	188.200	2.9%	90%	N/A

Source: FAA DOT/TSC CY1998 ACAIS Database, Yampa Valley Regional Airport Aviation Director

HDN's two runways are 10,000 feet long and 150 feet wide and composed of grooved asphalt. Six aircraft are based on the field and the air traffic control tower is staffed from 6:00am to 8:00pm. On average, HDN handles 23 flights per day with 44% of those flights being commercial air service. HDN is planning to complete a new 45,000 SF terminal in 2005 that will be designed for 2005 enplanement projections. Other improvements include development of general aviation facilities to meet demand.

Infrastructure features are summarized in Table 1.10 below.

Table 1.10 HDN Infrastructure Features YAMPA VALLEY REGIONAL AIRPORT (HDN)

Type of Airport Primary (primary, GA, military, reliever): **Runway Info** Two runways; Dimensions: 10,000 x 150 ft.; Surface: asphalt/grooved, in good condition; (length, width, Weight limitations: PCN 09/F/C/Z/T, Single wheel: 75000 lbs, Double wheel: 170000 lbs, capacity): Double tandem: 260000 Approach Type IFR on Runway 28 only (VFR, IFR): Based Aircraft: Aircraft based on field: 6; single engine airplanes: 6 Hangar Two hangars (storage and maintenance and tiedowns Facilities: Airport Alrcraft operations: average 23/day; 42% translent general aviation; 28% commuters; 16% **Operations:** commercial; 11% local general aviation; 3% air taxi; <1% military Air Traffic 6:00am to 9:00pm **Control:** Terminal 20,000 SF; two rental car agencles, three concessions and gift shop Features

Source: AirNav Yampa Valley Regional Airport Web Site





F.5 Flight departing from Yampa Valley Regional Airport

American Airlines has a cooperative service relationship with United Airlines and offers five daily one-stop flights (via Denver) from Dallas/Fort Worth, mid-December through March. Five additional one-stop flights also are offered during the same winter period in a cooperative service relationship with United. American Airlines primarily uses BAE 146 aircraft on the flights from Denver to HDN. Round-trip fares from DFW during the ski season were as low as \$524 for the least-expensive alternative.

Continental Airlines offers one daily nonstop flight from Houston (IAH). Four one-stop flights (via IAH) also are offered daily from Newark. Both routes are only available mid-December through March. Boeing 737 aircraft are used from IAH and Boeing 757 aircraft are used from Newark. Round-trip fares from Houston during the ski season were as low as \$276 for the least-expensive alternative. Round-trip fares from Newark during the ski season were as low as \$349 for the least-expensive alternative.

United Airlines offers two daily one-stop flights from Chicago O'Hare (via Denver) mid-December through March. Two daily flights are offered from Los Angeles (via Denver), mid-December through March. The connecting flights from Denver to Hayden are the same flight number for both Chicago and LAX flights. Dornier 328 aircraft primarily are used. Round-trip fares from Chicago during the ski season are \$1,172 for the least-expensive alternative. Roundtrip fares from LAX during the ski season are \$600 for the least-expensive alternative.

Air Activity Trends

Each of the primary airports in the mountain corridor projects steady increases in enplanements through 2020. General aviation facilities will be greatly improved by advances in air system technology and demand will outstrip supply. Other trends that are expected to impact air activity service in the mountain corridor are summarized as follows:

• Airline fleet changeovers from propeller driven aircraft to regional jet aircraft will boost aircraft capacity, serve greater markets, and attract air passengers previously unwilling to travel in propeller aircraft

• Advances in national air system technology that will "grow" the capacity of primary and general aviation facilities

• Greater pressure on summer recreational industries to help bear the costs of revenue guarantees and even-out the seasonal vagaries of air activity

• In the absence of greater marketing efforts, declines in out-of-state skiers, greater reliance on Front Range skiers

• With continued economic growth and aging Baby Boomer population, increased second-home development

As previously mentioned, compared with national data, enplanement projections for regional airports (such as ASE, EGE, GJT and HDN) are forecast to increase at an annual rate of 5.5% between 1998 and 2009. Enplanements are forecast to slow to 3.6% between 2010 and 2020.



Figure 6. Types of Aircraft Serving the Mountain Corridor Airports



Boeing 757



Dash 8



Domier 328





BAE 146

Boeing 737

Beechcraft 1900d

Historical and projected enplanements for the mountain corridor airports are summarized again in Table 1.11.

Table 1.11 Enplanement Activity for the Four Primary Airports

Airport	Historical Enplanements		Historical Annual Growth Rate	Projected Enplanements		Projected Annual Growth Rate	Seasonal Variation	Residential To Transient Ratio
	1991	1998		2010	2020			
ASE	206,041	249,651	2.80%	DNS	DNS	DNS	Winter, 50%	DNS
EGE	30,308	171,272	58%	200,000*	260,000*	5%	Winter, 70%	27%
GJT	133,735	129,697	-0.38%	264,000	299,800	2.3%	May-Oct, Slight ↑	30-40%
HDN	59,129	106,092	10%	128,800	188,200	2.9%	Winter, 90%	N/a

Source: FAA DOT/TSC CY1998 ACAIS Database, Airport Managers

* Projections for EGE are 2001 and 2006; Projections for HDN are 2005 and 2020



Access to Hub Airport Connections

Denver International Airport (DEN)

DIA, which is owned and operated by the City and County of Denver, is located 23 miles northeast of downtown Denver and is host to 20 passenger airlines. The Elrey B. Jeppesen Terminal is 1.5 million square feet and has three concourses with 94 gates. There are five runways, each 12,000 feet in length. An average of 104,000 passengers passed through the airport on a daily basis in 1999, accessing the airport by an average of 1,371 daily flights. Passenger enplanements grew 5.3% over 1997 figures with 36,831,400 enplanements in 1998.

DIA's busiest months, in order, are August, July and March. July and August are typical vacation months. March is the busiest ski month and schools typically schedule spring breaks during that month.

One hundred (100) nonstop domestic destinations and 10 nonstop international destinations are available from the airport, including service to the four mountain corridor airports. These flights are offered on Air Wisconsin (United Express), Great Lakes Aviation (United Express), Mesa Airlines (America West), Delta, Northwest, American, Continental, and Trans World Airlines.

Numerous charter and scheduled shared-ride transportation is available from DIA to the mountain resorts. There is some seasonality to the ground services due to fluctuations in tourist activity throughout the year.

Colorado Springs Airport (COS)

Colorado Springs Airport (COS) is owned and operated by the City of Colorado Springs. A new airport with new landside and airside facilities opened in October 1994 and is located 20 minutes east of Downtown Colorado Springs. COS handles approximately 100 combined arrivals and departures each day. There are five runways, each 12,000 feet in length. Currently, eight commercial airlines operate from the airport which as 12 gates in its 270,000 SF terminal. The terminal has three restaurants, five car rental agencies, two gift shops and miscellaneous concessions and vending machines.

In 1999, COS had 2,481,098 passenger enplanements, 60% of which were business-related and 40% of which were leisure-related. Twelve nonstop destinations are available from the airport, however none of those include the four mountain corridor airports. COS passengers seeking access to the mountain resorts by air, must take connecting flights at DIA. Presently, there are no scheduled shared-ride ground transportation services available from COS to the mountain resorts. Charter services are available, however.



General Aviation

General aviation activity occurs at each of the four mountain corridor commercial airports. Based on daily averages, local and transient GA activity can be summarized as follows:

Table 1.12 Percentage of General Aviation Aircraft Operations at Mountain Commerce	ial
Aviation Facilities	

	Transient GA	Local GA	Total Daily GA		Total Aircraft Operations/ GA % of Total
ASE	71	11	82	29,930	45,625/66%
EGE	42	13	55	20,075	32,120/63%
GJT	93	60	153	55,845	86,870/64%
HDN	10	3	13	4,745	8,395/57%

Source: AirNav websites for ASE, EGE, GJT, and HDN

GA activity includes everything from single-engine propeller-driven aircraft to sophisticated corporate jets. General aviation airports in the mountain corridor include Garfield County Regional Airport, Glenwood Springs Municipal Airport, Kremmling Airport (formerly McElroy Airfield), Lake County Airport, and Steamboat Springs/Bob Adams Field. These airports have critical significance to a region even when shared with a primary airport as they transport cargo and provide air ambulances services and charter and aircraft rental.

Garfield County Regional Airport (RIL)

Garfield County Regional Airport is owned by Garfield County and operated by the Garfield County Airport Authority. Located three miles east of Rifle, this facility has one runway that is 7,000 feet in length with an asphalt surface. Its weight limitations are single wheel, 52,000 pounds and double wheel, 68,000 pounds. Air taxi (36%) and general aviation (local, 20%; transient, 44%) make-up the bulk of its aircraft operations. RIL is planning for significant GA growth and has added two new hangars (totaling 30,000 SF) and an extended taxiway to accommodate greater cueing at takeoff and arrival. RIL saw a 44% increase in fuel sales from 1998 as it continues to handle a lot of Aspen GA traffic.

Glenwood Springs Municipal Airport (GWS)

GWS has one runway with a length of 3,300 feet. Nearly 80% of its aircraft operations is local general aviation and 14% is transient general aviation. The balance is air taxi (6%) and military (less than 1%). For five years, the airport's capital improvement plan has included plans for siting of a new GA facility because the existing site cannot expand to meet GA demand due to the river valley terrain. However, with the bulk of FAA funding dedicated to ASE, GWS must rely on lease arrangements to fund any improvements or new facilities. GWS currently contracts with Rifle Air Field (another GA facility about 30 miles west of GWS along I-70) for maintenance service which it cannot provide due to facility constraints.

Kremmling Airport (20V)

Kremmling Airport (formerly McElroy Field) is located 50 miles from the junction of I-70 and State Highway 9, on the north side of the corridor. It is approximately 70 miles south of Steamboat Springs, the resort community served by HDN. 20V has two runways, 5,500



(asphalt) and 1,100 (turf) feet in length. With only 73 combined arrivals and departures per week, the bulk of aircraft operations is transient general aviation (67%), local general aviation (29%) and air taxi (4%). Minor improvements have been made to the airport through the last decade, but major capital improvements include runway strengthening to increase weight limitations from 22,000 pounds single axle to 68,000 pounds double axle, which would be comparable to weight limitations for EGE and HDN.

Lake County Airport (LXV)

Located two miles southwest of Leadville, LXV is sited at an elevation of 9,927 feet, and claims to be the highest airport in North America. It has one runway that is 6,400 feet in length with an asphalt surface that accommodates single wheel, 20,000 pounds, and double wheel, 20,000 pounds. This airport also has a Helipad H1 that is 150×100 feet with a concrete surface. Nearly 80% of aircraft activity is transient (50%) and local (28%) general aviation with military operations being 20%.

Steamboat Springs/Bob Adams Field (SBS)

Three miles northwest of Steamboat Springs, this GA facility actually has more aircraft based on the field than HDN -42 compared to six - including a helicopter. SBS has one runway that is 4,400 feet in length with an asphalt surface that can accommodate single wheel, 12,500 pounds and double wheel, 55,000 pounds. Transient (47%) and local (47%) general aviation make-up the bulk of its air activity with 4% being commercial cargo (Federal Express and Clark's Grocer Association). Airport officials in the area consider themselves fortunate to have a significant GA facility and primary airport in the same region with close proximity to the resort areas.

Air Cargo

Air cargo is typically transported in the baggage compartments of scheduled passenger aircraft and by all-cargo aircraft. With regard to its impact on the need for greater airport capacity, most all-cargo flights are scheduled during off-peak periods and to not substantially contribute to airport congestion and delay problems.

Historically, air cargo service has not substituted in any significant way for freight shipping by truck to the communities and airports in the mountain corridor. Ground transportation remains the most economical means of shipment and a regional cargo hub is not expected to significantly reduce surface traffic volumes on I-70. At best, an individual aircraft might reduce the highway impact by only a single truck.

However, with global supply chains, production flexibility and speed characterizing the economy, it is certain that air cargo will play an increasingly important role. For example, according to The International Air Cargo Association, shipments passing through Southern California, already totaling three million tons annually, are forecasted to reach nine million tons annually in less than two decades, with LAX accounting for just under half of this volume. Additionally, just-in-time logistics will require that producers receive and ship smaller quantities more frequently and quickly over long distances. Air freight was once considered a luxury and reserved for small, lightweight, compact products with high value-to-weight ratios or to items

needed on an emergency basis at distant sites. In the future, essentially anything that can be loaded onto a large aircraft will routinely be shipped by air.

Other Mountain Corridor Airports

There are other commercial service airports in the mountain region of Colorado and they include Gunnison County Airport (GUC), Montrose Regional Airport (MTJ), and Telluride Regional Airport (TEX). All three of these airports are located within the general road network of the I-70 corridor, but are not as readily accessible to the highway. GUC is located 66 miles beyond Montrose to the east on U.S. 50. GUC enplaned 58,518 passengers in 1998. MTJ is located 60 miles south of Grand Junction on U.S. 50. MTJ enplaned 64,992 passengers in 1998. TEX is located 60 miles south of Montrose from I-70. In 1998, TEX enplaned 18,202 passengers. Enplanement activity at all three airports is driven by winter ski markets.

A study of the feasibility of developing a new commercial service airport six miles south of the town of Fairplay in Park County, was conducted in the late 1980s. Sited between U.S. 285 and S.H. 9, the proposal lacked public support because of cost, ground access reliability, and lengthy travel times to the winter recreational areas relative to the other existing commercial service airports.



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Appendix H.

TranSystems. 2001. I-70 PEIS Aviation Alternatives—Estimates of Auto Trips Diverted (memorandum). March.



559 E. Pikes Peak Ave. Suite 300 Colorado Springs, CO 80903 (719) 634-5579 (719) 634-5547 FAX

	Memorandum					
FROM: Date: RE:	Tim Tetherow, Jl Joanne Greek March 6, 2001 I-70 PEIS Aviatic Bill Stringfellow	F Sato on Alternatives Estimates o	f Auto Trips Diverted			
	r Information	Urgent				
As Requ		For Review and Com	ment			

Tim,

I've chosen this memo format to communicate my findings regarding the above. Don't hesitate to call if you have any questions, 719-634-5579.

PURPOSE: As CDOT has requested, I have researched the impact of technological modernization and capital improvement projects on enplanements in the three mountain corridor commercial service airports, Eagle County (EGE), Aspen/Pitkin County Sardy Field (ASE), and Yampa Valley Airport (HDN), and the general aviation facilities (Glenwood Springs, Kremmling, Rifle, Steamboat Springs and Lake County). CDOT also was interested in the impact of seat guarantees on air service demand.

METHODOLOGY: Airport managers for each of the airports were contacted and asked to supply numbers regarding typical diversions of flights to other airports (due to weather or the inability to accommodate flights due to inadequate technology or physical capacity). Managers also were asked to project additional enplanements that could be accommodated if their airports added capital construction projects or technology *not already included in their five-year CIPs.* (The intent of excluding items already in their CIPs, is to gauge the impact additional projects or technology could have, as their CIPs are based on expected growth projections already.) Phone calls also were placed to Travis Vallin, CDOT Aeronautics Division Director; Alan Wiechmann, FAA Denver Airports District Office Manager; and Charlie Mayfield, Marketing Director with Colorado Ski County USA.

RESULTS: Both Jim Elwood (EGE) and Jim Parker (HDN) supplied anecdotal information but said it was difficult to identify the number of diversions because the FAA only requires this information for large hub airports and they would have to contact each of their airlines directly for the information. If this information can be obtained, however, both have promised to forward it to me as soon as possible. Peter Van Pelt from ASE did not respond. Both Travis and Alan offered anecdotal information as well.

Page 2 of 2

MEMO Tim Tetherow February 22, 2001

FINDINGS: There was general concurrence by those contacted, that the airport capacity issue was best framed by asking the question: By 2010, without improved radar equipment and runway extensions (by at least 1000'), can ASE and EGE (as well as Rifle's general aviation facility) grow beyond their current projections? (For these projections, see I-70 Mountain Corridor Air Service Characteristics & Operational Inventory, July 2000.) It was projected that without these improvements -- radar or ASR11 for EGE (which would address inadequacies at EGE, ASE and Rifle) and runway extensions for all three airports – 500 to 1,000 average daily person trips would be added to I-70 over a 100-day winter season period.

With regard to seat guarantees, Travis and Alan suggested that the impact is negligible because outof-state skiiers already have chosen to fly directly into mountain airports to access the resorts. Presently, the airlines reportedly are meeting their respective load factors and the resorts have not had to "ante up" the difference to ensure air service continues. This situation requires further investigation as there appears to be a significant number of resort-bound fliers who fly into DIA and rent cars or use the various privately operated shuttles to access the resorts. Research will continue to determine how long this present situation is expected to last and whether profitable load-factors are expected to continue. Information regarding estimated auto-trips diverted due to seat guarantees will be forwarded when and if they become available.

CS-Joanne P. Greek

From:Alan Wiechmann [Alan.Wiechmann@faa.gov]Sent:Monday, February 26, 2001 1:18 PMTo:jpgreek@transystems.comCc:Jim.Fels@faa.govSubject:Follow-up to our 2/22 phone callJoAnne,

During instrument weather conditions and busy days of the year, the number of arrivals and departures at the Eagle County Regional Airport, Aspen-Pitkin County Airport, and Garfield County Airports is limited by the radar coverage. Airport Surveillance Radar (ASR) would increase capacity. From our discussion, I believe you are trying to quantify the benefits to the I-70 corridor of increased arrival and departure capacity into these airports.

The three airports currently handle approximately 800,000 airline passenger and 200,000 general aviation passenger each year. If all of these people flew into other airports like Grand Junction or DIA and then drove to their destination, it would probably average at least 1000 trips per day. When people arrive at Eagle, Aspen, or Rifle they also take ground transportation to a destination, but the distance is a fraction of the miles.

During instrument weather some users currently do not get to those airport because of capacity constraints. Demand is significant at these airports and activity is expected to grow faster than the national average. Activity should double in 15 years. During instrument weather the number of days with delays will go up dramatically. The airlines may schedule more flights but many more will experience delays even of hours instead of minutes. This lack of reliability will decrease use by passengers and expansion by the airlines. Also more general aviation flights will end at other airports with the passengers taking rental cars to destinations. While pure demand may predict a doubling of airport use, the actual growth may only be half of less. The balance will be taking flights into DIA, Grand Junction, or other airports and then using ground transportation. I believe an educated guess of the positive effect of an ASR 15 years from now would be a reduction of 500 vehicle trips per day.

We don't know how many flights or passenger are currently avoiding the airports because of delays, but it is probably something less than an average of 50 per day. I would expect an ASR installed today would remove 50 trips per day from I-70. It should grow to at least a 500 trip per day savings in 15 years.

We also talked about a runway extension at Eagle for improved summer service. Eagle presently handles almost 350,000 passengers in the winter. Summer service estimates are usually around 250,000 additional passengers. I estimate this would remove 500 I-70 vehicle trips per day.

Improvements at the Garfield County Airport would encourage more use by general aviation pilots. Its affect on I -70 would be minimal and I would estimate an elimination of 50 I-70 trips/day.

I hope this helps.

Alan Wiechmann

Appendix I Colorado Department of Transportation I-70 Mountain Corridor PEIS Alternate Routes Technical Report August 2010 This page intentionally left blank.

1	I-70 Mountain Corridor PEIS Screening of Alternate Routes
2	Technical Report
3	August 2010

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Screening of Alternate Routes Technical Report

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1 Section 1. Purpose of the Report

2 This I-70 Mountain Corridor PEIS Screening of Alternatives Routes Technical Report supports the

information contained in Chapter2 of the I-70 Mountain Corridor Preliminary Environmental Impact
 Statement (PEIS). It identifies:

- 5 The 17 alternative routes identified in the I-70 Mountain Corridor PEIS
- 6 The results of the Level 1 and Level 2 screening of alternative routes
- 7 The public involvement activities during the screening of alternative routes process

8 Section 2. Background and Methodology

- 9 This Technical Report provides an overview of the screening process applied to alternate routes identified
- 10 in the I-70 Mountain Corridor PEIS, as well as a description of the alternate routes and results from Level

11 1 and Level 2 screening of alternate routes. This Technical Report is based on the *Descriptions of*

- 12 *Alternate Highway Routes* report (Felsburg Holt & Ullevig, June 2000).
- 13 Alternate routes were explored as a potential strategy to achieve the goals of the I-70 Mountain Corridor

14 PEIS. This concept of alternative routes was investigated previously as a part of the *I-70 Corridor Major*

- 15 Investment Study. Alternate routes were analyzed to determine roadway improvements necessary to make
- 16 these routes viable alternatives to the I-70 highway. The mountainous terrain encountered west of Fort
- 17 Collins, Denver, Colorado Springs, and Pueblo severely limits the range of alternate routes. Many of the
- 18 concepts involved improving existing state highways and building new connections (often tunnels) to
- 19 shorten distances and travel times. In identifying potential new connections, special care was taken to
- 20 avoid wilderness areas where disturbance (and road construction) is prohibited.
- 21 For purposes of comparison with current travel patterns along the I-70 highway, existing and new
- 22 roadway segments were combined in various ways to develop alternate routes between cities along the
- 23 Front Range and destinations currently served by the I-70 highway. Alternate routes have been defined
- both north and south of the I-70 highway. Fort Collins (including Greeley, Loveland, and Longmont), the
- 25 Denver metropolitan area, Colorado Springs, and Pueblo were specifically considered because of their
- 26 populations and their proximity to the I-70 Mountain Corridor via I-25.

27 2.1 Existing Travel Shed Characteristics

- Figure 1 depicts the greater travel shed extending westerly along the I-70 highway from Denver to
- 29 Glenwood Springs and along I-25 between Fort Collins and Pueblo. Within this travel shed, numerous
- 30 state highways and state highway segments potentially serve as alternate routes for certain trips now using
- 31 the I-70 highway. Detailed physical and operational data collected for each existing state highway
- 32 segments is shown in **Figure 1** and summarized in **Appendix A**.
- 33 The travel shed is characterized by topographically constrained two-lane highways with four-lane and
- 34 six-lane segments emanating from the edges of the major metropolitan areas. Traffic volumes are
- 35 generally less than 10,000 vehicles per day in the rural areas, and travel speeds are typically at the posted 36 speed limits.
- 36 speed limits.
- 37 To provide a general frame of reference, travel distances from the four major Front Range cities to the
- 38 central Rocky Mountains (Copper Mountain) were calculated and are included in **Figure 1**. Note that trips
- 39 between Fort Collins and the I-70 Mountain Corridor area are constrained to use I-25 to Denver and west
- 40 on the I-70 highway. Alternate routes for these trips are essentially non-existent due to the presence of

Screening of Alternate Routes Technical Report

- 1 Rocky Mountain National Park and the severe topography that characterizes areas west of I-25 and north 2 of the I-70 highway.
- 3
- To the south of the Corridor, more direct connections are possible between the central Rocky Mountains 4 and Colorado Springs or Pueblo. These include State Highway (SH) 9 south from Breckenridge, which
- 5 intersects with United States Highway (US) 24 (to Colorado Springs) and with US 50 (to Pueblo). As a
- 6 consequence, very few trips from Colorado Springs or Pueblo use the I-70 highway to reach the central
- 7 Rocky Mountains.

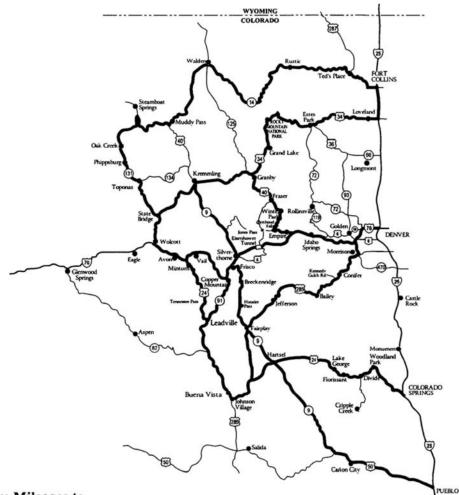


Figure 1. Comparative Mileages to Central Rocky Mountains

Comparative Mileages to Central Rocky Mountains (Copper Moutain)

FROM	VIA SHORTEST ROUTE	VIA I-70
Ft. Collins	135 mi.	135 mi.
Denver	79 mi.	79 mi.
Colorado Springs	118 mi.	144 mi.
Pueblo	147 mi.	186 mi.

1 2.2 Planned Travel Shed Improvements

2 The Colorado Department of Transportation continuously monitors the state highway network to

3 determine where future improvements should be made. Within the greater I-70 Mountain Corridor travel

4 shed, more than 25 planning studies and improvement projects are programmed to occur over the next

5 six years. These activities include various safety improvements, minor widenings, and major capacity

- 6 increases. The proposed improvements within the I-70 Mountain Corridor travel shed are depicted in
- 7 **Figure 2**.
- 8 All of these improvements, to some extent, improve the travel time along any given highway segment
- 9 and, therefore, any combination of segments comprising an alternate route to the I-70 highway. Figure 2
- 10 shows comparative travel times between the four major Front Range cities and the central Rocky
- 11 Mountain area (Copper Mountain). Note that only trips from the Colorado Springs area (i.e., US 34
- 12 corridor) are susceptible to diversion from the I-70 highway due to travel time improvements. If travel
- 13 time savings of more than six minutes could be achieved, it is probable that trips to the central Rocky
- 14 Mountains from Colorado Springs could be diverted off the I-70 highway.
- 15 By contrast, trips between Pueblo and the central Rocky Mountain area are probably already using US 50
- 16 and SH 9 to a large degree since this route is not only 12 minutes faster but also 39 miles shorter.

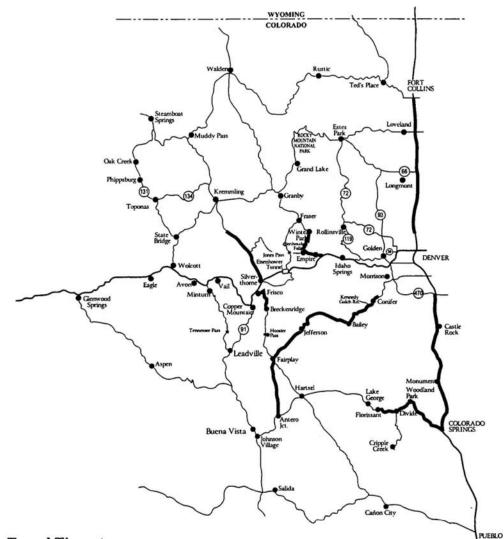


Figure 2. Comparative Travel Times to Central Rocky Mountains After Completion of CDOT's 6-year Improvement Program

Comparative Travel Times to Central Rocky Mountains (Copper Moutain)

(After Completion of CDOT's 6 Year Improvement Program)

FROM	VIA SHORTEST ROUTE	VIA I-70
Ft. Collins	119 min.	119 min.
Denver	74 min.	74 min.
Colorado Springs	137 min.	131 min.
Pueblo	158 min.	170 min.

3

Section 3. Description of Alternate Routes

2 Seventeen alternate routes were identified with eastern termini ranging from Fort Collins to Pueblo and 3 western termini at various points along the I-70 highway west of the Continental Divide as far west as Wolcott in Eagle County. These 17 alternate routes would connect the central Rocky Mountains with the 4 5 four principal cities along the Front Range. Three alternate routes would connect with Fort Collins, eight 6 with Denver and Denver International Airport, four with Colorado Springs, and two with Pueblo. These 7 routes are shown on Figure 3. 8 Alternate Route 1 – Fort Collins to Wolcott via Walden (SH 14/SH 131) 9 Alternate Route 2 – Fort Collins to Wolcott via Kremmling (US 34) 10 Alternate Route 3 – Fort Collins to Copper Mountain via Kremmling (US 34/SH 9) 11 Alternate Route 4 – Denver to Wolcott via Moffat Tunnel (SH 72/US 40/US 34) 12 Alternate Route 5 – Denver to Copper Mountain via Moffat, Berthoud, and Jones Pass Tunnels 13 (SH 72/SH 9) Alternate Route 6 – Denver to Wolcott via Berthoud Pass Tunnel (SH 40/US 34) 14 15 Alternate Route 7 – Denver to Copper Mountain via Jones Pass Tunnel (SH 9) Alternate Route 8 - Denver to Copper Mountain via Hoosier Pass - Surface (US 285/SH 9) 16 17 Alternate Route 9 – Denver to Copper Mountain via Georgia Pass Tunnel (US 285) Alternate Route 10 – Denver to Minturn via Buena Vista (US 285/US 24) 18 19 Alternate Route 11 - Colorado Springs to Copper Mountain via Hoosier Pass - Surface 20 (US 24/SH 9) 21 Alternate Route 12 - Colorado Springs to Copper Mountain via Hoosier Pass Tunnel 22 (US 24/SH 9) 23 Alternate Route 13 – Colorado Springs to Minturn via Buena Vista (US 24) 24 Alternate Route 14 – Colorado Springs to Copper Mountain via Buena Vista (US 24/SH 91) 25 Alternate Route 15 – Pueblo to Copper Mountain via Hoosier Pass - Surface (US 50/SH 9) 26 Alternate Route 16 – Pueblo to Copper Mountain via Hoosier Pass - Tunnel (US 50/SH 9) 27 Alternate Route 17 - Denver to Winter Park via New Tunnel Parallel to Moffat Tunnel (SH 58, 28 SH 93, and SH 72) to Wolcott

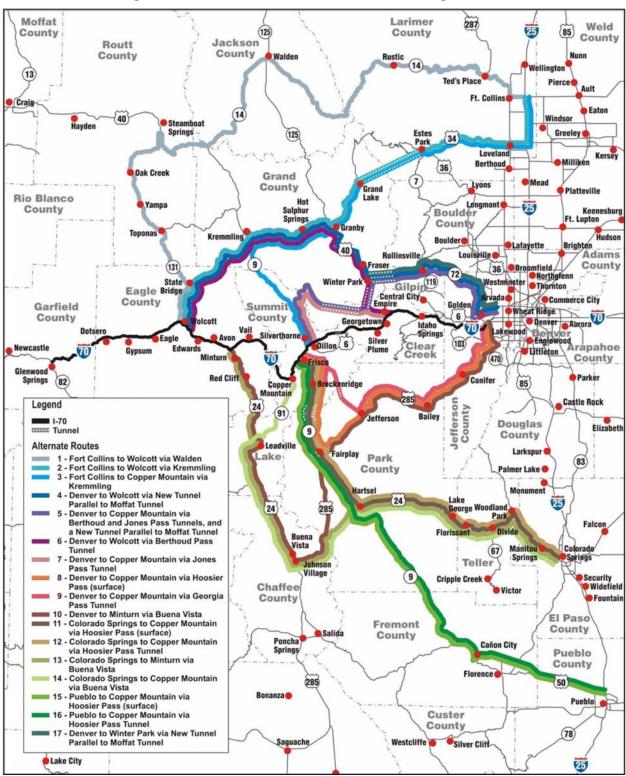


Figure 3. Alternate Routes Considered in Screening Process

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- 1 The eastern termini range approximately 160 miles north and south of the Denver metropolitan area
- 2 extending between Fort Collins to Pueblo. The western termini occur at various points along the I-70
- 3 highway west of the Continental Divide extending as far as Wolcott in Eagle County.

4 The descriptions on the following pages provide an overview of the basic route characteristics, the key 5 features, and provide an illustration of each alternate route developed for screening Level 1 and Level 2.

Alternate Route 1 – Fort Collins to Wolcott via Walden (SH 14/SH 131)

8 Alternate Route 1 (AR-1) would use existing state highways along its entire length. SH 14 would provide

9 the connection between Fort Collins and the junction of SH 14 and US 40 at Muddy Pass (**Figure 4**).

10 Topographic constraints through the lower reach of the Cache la Poudre Canyon would prohibit any 11 upgrades to SH 14 from Ted's Place to a point just east of Rustic. At this point, SH 14 would be widened

to three lanes providing an uphill passing lane to Walden. West of Walden to Muddy Pass, SH 14 remains

- 12 to three lanes providing an upnil passing lane to walden. West of walden to Muddy Pass, SH 14 remains 13 two lanes. The route would then continue on US 40 over Rabbit Ears Pass until it connects to SH 131 just
- 14 south of Steamboat Springs. Most of US 40 on Rabbit Ears Pass already has three lanes for uphill
- 15 climbing.
- 16 The route would turn south on SH 131 to State Bridge and pass through Oak Creek, Phippsburg, and

17 Toponas enroute. These segments of SH 131 remain two-lane highways. Finally, the section of SH 131

18 between State Bridge and the I-70 highway at Wolcott would be upgraded to three lanes for uphill

19 climbing.

Figure 4. Alternate Route 1 – Fort Collins to Wolcott via Walden (SH 14/SH 131)



13.2Alternate Route 2 – Fort Collins to Wolcott via Kremmling2(US 34)

3 Alternate Route 2 (AR-2) would use two new road segments to connect existing state highways. From

4 Fort Collins to Estes Park, the route would use existing I-25 and US 34. US 34 between Loveland and

5 Estes Park would not be widened because of the topographic constraints through the Big Thompson

6 Canyon. A long tunnel (approximately 12.2 miles) would be built under Rocky Mountain National Park

7 from Estes Park to Grand Lake, generally paralleling the Alva B. Adams water tunnel (Figure 5).

8 Existing US 34 with no widening would be used between Grand Lake and Granby. Existing US 40, also

9 with no widening, would be used between Granby and Kremmling. A new two-lane roadway would be

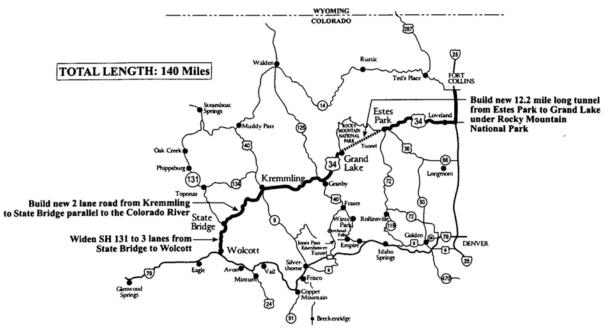
10 built between Kremmling and State Bridge, which would follow the Colorado River. At State Bridge, the

11 route would use SH 131 to travel south to Wolcott. As was the case with AR-1, SH 131 would be

12 widened to three lanes through this section to provide an uphill passing lane.

13

Figure 5. Alternate Route 2 – Fort Collins to Wolcott via Kremmling (US 34)



Alternate Route 3 – Fort Collins to Copper Mountain via 3.3 1 Kremmling (US 34/SH 9) 2

3 Alternate Route 3 (AR-3) would be identical to AR-2 between Fort Collins and Kremmling and would

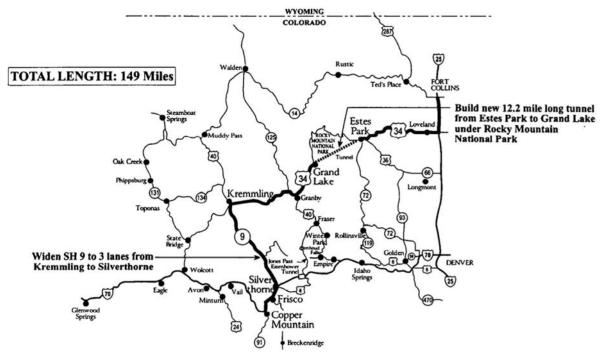
4 include the new tunnel under Rocky Mountain National Park (Figure 6). To get to Copper Mountain,

5 SH 9 from Kremmling to Silverthorne (junction of the I-70 highway and SH 9) and the I-70 highway

6 would be used. SH 9 south of Kremmling to Silverthorne would be upgraded from two to three lanes for 7

- an uphill passing lane. At Silverthorne, the I-70 highway west would be used to complete the route to
- 8 Copper Mountain.

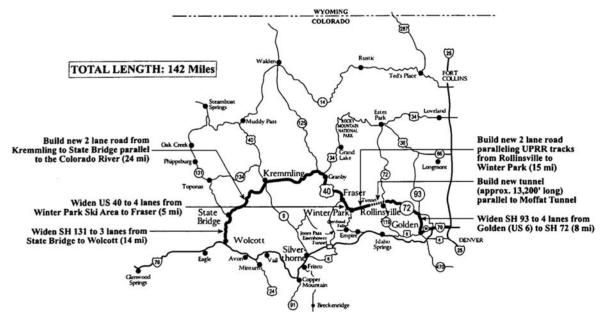
9 Figure 6. Alternate Route 3 – Fort Collins to Copper Mountain via Kremmling (US 34/SH 9)



13.4Alternate Route 4 – Denver to Wolcott via the Moffat Tunnel2(SH 72/US 40/US 34)

- Alternate Route 4 (AR-4) would use eight state highways, a new tunnel, and a new route between
- 4 Kremmling and State Bridge (**Figure 7**).
- 5 From the Mousetrap (I-25 and the I-70 highway interchange), the I-70 highway and SH 58 would be used
- 6 as a route to Golden. Traveling north, SH 93 from Golden to its junction with SH 72 would be upgraded
- 7 to a four-lane highway. From this junction, the route would use SH 72 and SH 119 to Rollinsville. There
- 8 would be no widening on this section, although a number of sharp curves would need to be flattened as
- 9 much as possible.
- 10 A new two-lane highway would be built west from Rollinsville that would generally follow the existing
- 11 gravel road paralleling the Union Pacific Railroad tracks. A new two-lane tunnel (approximately
- 12 13,200 feet long) would be constructed along the alignment of the Moffat Tunnel, which would end at US
- 13 40 near the Winter Park Ski Area. US 40 would be used north to Granby and then west to Kremmling.
- 14 The short stretch of US 40 from the ski area to Fraser would be widened to provide four through lanes.
- 15 The remainder of US 40 would remain a two-lane highway.
- 16 To complete the route to Wolcott, the route would use a new two-lane highway from Kremmling to State
- Bridge (as previously described in AR-2) and an improved SH 131 (as previously described in AR-1) to
- 18 Wolcott.

19 Figure 7. Alternate Route 4 – Denver to Wolcott via the Moffat Tunnel (SH 72/US 40/US 34)



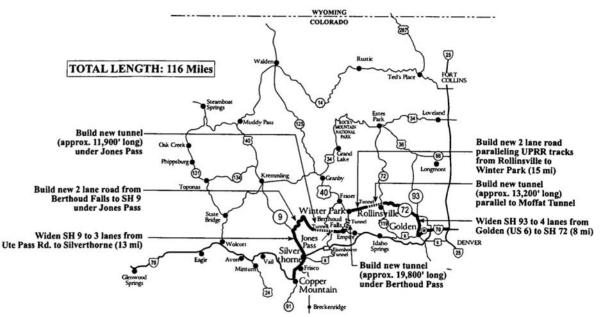
3.5 Alternate Route 5 – Denver to Copper Mountain via Moffat, Berthoud Pass, and Jones Pass Tunnels (SH 72/SH 9)

Alternate Route 5 (AR-5) would require the construction of three new tunnels. From Denver to Winter Park, the route would be identical to AR-4 and use SH 93, SH 72, and the new tunnel parallel to the Moffat Tunnel (**Figure 8**). At the Winter Park Ski Area, this route would turn south on US 40 and use the Berthoud Pass Tunnel. At the south end of the Berthoud Pass Tunnel, the route would turn west on US 40 to Berthoud Falls. At this point, the route would use the new Jones Pass Tunnel and the new two-lane highway to connect to SH 9. To get to Copper Mountain, SH 9 would be used to travel to Silverthorne and then the I-70 highway to connect to Copper Mountain. SH 9 from Ute Pass Road to Silverthorne

10 would be widened to three lanes providing an uphill passing lane.

11 12

Figure 8. Alternate Route 5 – Denver to Copper Mountain via Moffat, Berthoud Pass, and Jones Pass Tunnels (SH 72/SH 9)



13.6Alternate Route 6 – Denver to Wolcott via Berthoud Pass2Tunnel (SH 40/US 34)

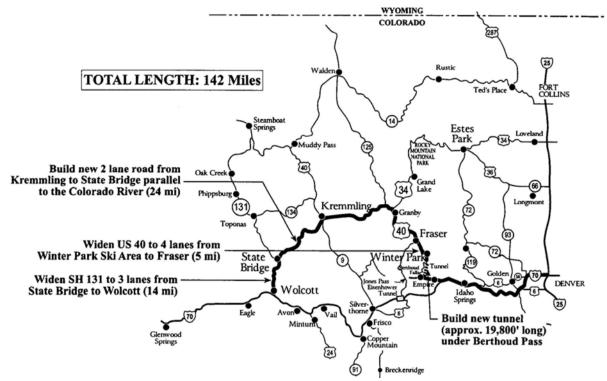
3 Alternate Route 6 (AR-6) would use the I-70 highway from Denver to the junction of the I-70 highway

4 with US 40 near Empire and a new tunnel under Berthoud Pass (**Figure 9**). The new two-lane tunnel

5 (approximately 19,800 feet long) would leave US 40 approximately halfway between Empire and

- 6 Berthoud Falls in the vicinity of Blue Creek and would provide a by-pass to the steep grades and
- 7 switchbacks of Berthoud Pass. The north end of the tunnel would be located at the last switchback on US
- 8 40. Investigations for a potential toll tunnel on this alignment were conducted several years ago. US 40
- 9 between Empire and the new tunnel would remain a two-lane highway. The remainder of this route from
- 10 Winter Park to Wolcott would be identical to the previously described AR-4.

11 Figure 9. Alternate Route 6 – Denver to Wolcott via Berthoud Pass Tunnel (SH 40/US 34)



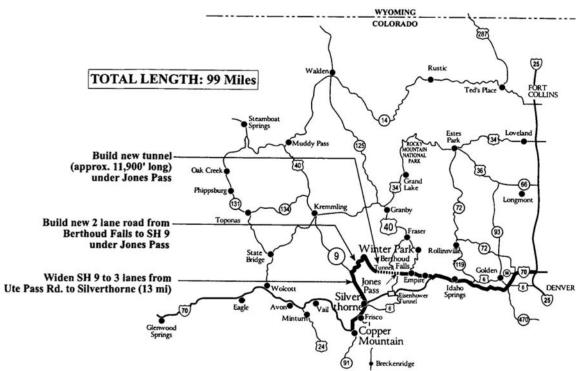
3.7 Alternate Route 7 – Denver to Copper Mountain via Jones Pass Tunnel (SH 9)

Alternate Route 7 (AR-7) would use the I-70 highway from Denver to Empire and then US 40 from
 Empire to Berthoud Falls (Figure 10). At Berthoud Falls, a new two-lane highway would be built to the

5 west to provide a more direct connection between US 40 and SH 9. The new highway would leave US 40

- 6 and travel west to Jones Pass. At Jones Pass a new two-lane tunnel (approximately 11,900 feet long)
- 7 would be constructed. West of Jones Pass the new highway would turn to the northwest and follow the
- 8 Williams Fork. It would intersect FR 132 (Ute Pass Road) and then follow it southwest over Ute Pass to
- 9 intersect SH 9. The route would continue south on SH 9 to Silverthorne and then turn west on the I-70
- 10 highway to Copper Mountain. The section of SH 9 south from Ute Pass Road to Silverthorne would be
- 11 widened to three lanes to provide an uphill passing lane.

12 Figure 10. Alternate Route 7 – Denver to Copper Mountain via Jones Pass Tunnel (SH 9)



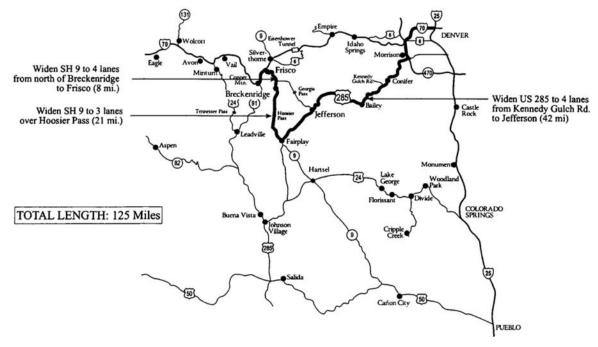
3.8 Alternate Route 8 – Denver to Copper Mountain via Hoosier Pass - Surface (US 285/SH 9)

3 Alternate Route 8 (AR-8) would follow the I-70 highway and C-470 from Denver to Morrison and then

4 US 285 to the town of Jefferson. US 285 would be widened to four lanes for this entire segment

5 consistent with the widening done through Turkey Creek Canyon to Kennedy Gulch Road (Figure 11).

- 6 AR-8 would continue along US 285 to Fairplay and then follow SH 9 northerly across Hoosier Pass into
- 7 Breckenridge. Widening of SH 9 to four lanes would be completed between Breckenridge and Frisco. At
- 8 Frisco, the I-70 highway would complete the alternate route to Copper Mountain.
- 9 Figure 11. Alternate Route 8 Denver to Copper Mountain via Hoosier Pass-Surface (US 285/SH 9)



3.9 Alternate Route 9 – Denver to Copper Mountain via Georgia Pass Tunnel (US 285)

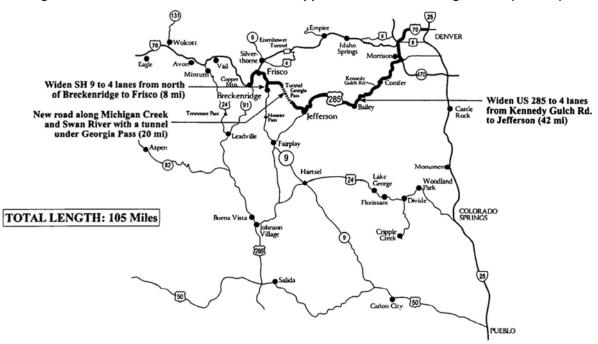
3 Alternate Route 9 (AR- 9) would use the I-70 highway and C-470 from Denver to Morrison, then use US

4 285 between the Denver metropolitan area and the town of Jefferson (**Figure 12**). At this point, a new

5 roadway would be built to provide a shorter connection to Breckenridge and Summit County. US 285

- 6 would be widened to four lanes through Turkey Creek Canyon to Kennedy Gulch Road. For this alternate,
- 7 the widening of US 285 would be continued all the way to Jefferson. The short section of four lanes
- 8 through Bailey would remain as it currently is. The new segment of road would leave US 285 at Jefferson 9 and travel porthwest up Michigan Creek. A two leave tweed (opprovidently 10 (00 fort leave) multily
- 9 and travel northwest up Michigan Creek. A two-lane tunnel (approximately 10,600 feet long) would be
- constructed under Georgia Pass. The road would continue down Tiger Road to an intersection with SH 9,
 north of Breckenridge. SH 9 from north of downtown Breckenridge to Frisco would be widened to four
- 12 lanes and at Frisco, the I-70 highway would be used to complete the route to Copper Mountain.

13 Figure 12. Alternate Route 9 – Denver to Copper Mountain via Georgia Pass (US 285)



3.10 Alternate Route 10 – Denver to Minturn via Buena Vista (US 285/US 24)

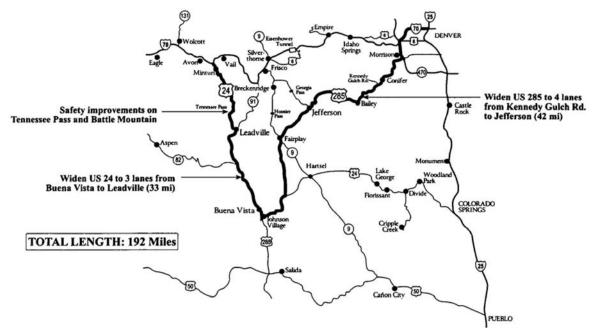
3 Alternate Route 10 (AR-10) would use existing highways to connect Denver with Minturn (**Figure 13**). It

4 would include the previously described widening of US 285 between Kennedy Gulch Road and Jefferson

5 (AR-8). The route would continue along US 285 to Johnson Village with no major improvements. At this 6 point, the route would continue on US 24 through Buena Vista and Leadville and end at Minturn where

- 7 US 24 meets the I-70 highway at Dowd Canyon. The section between Buena Vista and Leadville would
- 8 be widened to three lanes to provide an uphill passing lane. There would be no major widening between
- Leadville and Minturn because topographic constraints would restrict widening to short segments of
- 10 climbing lanes and safety improvements.

11 Figure 13. Alternate Route 10 – Denver to Minturn via Buena Vista (US 285/US 24)



13.11Alternate Route 11 – Colorado Springs to Copper Mountain2via Hoosier Pass - Surface (US 24/SH 9)

3 Alternate Route 11 (AR-11) would upgrade two existing state highways to connect Colorado Springs with

4 Summit County and its ski areas (Figure 14). US 24 between Colorado Springs and Woodland Park is

5 currently a four-lane highway with a wide median. West of Woodland Park, US 24 would be widened to

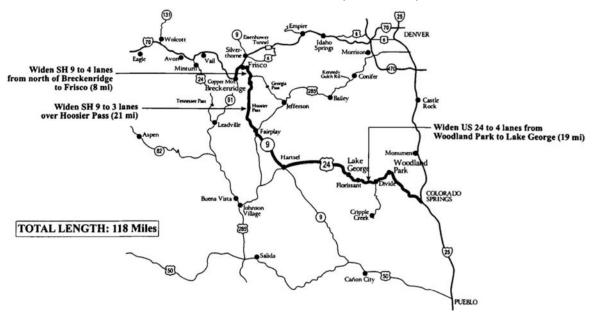
- 6 four lanes to the vicinity of Lake George. This would provide additional capacity through Divide (and the
- 7 SH 67 connection to the gambling casinos in Cripple Creek) and Florissant. The segment of US 24
- 8 between Lake George and Hartsel would remain as a two-lane highway.

9 The route would use existing SH 9 between Hartsel and Breckenridge. The segment of SH 9 over Hoosier

- 10 Pass would he upgraded to three lanes for an uphill passing lane, and existing switchbacks on the north
- side of the pass would be straightened to the extent possible. Mainstreet through Breckenridge would
- 12 remain as it is today _a two-lane road through the middle of a historic town. From north of downtown
- 13 Breckenridge to Frisco, SH 9 would be widened to four lanes. At Frisco, two interchanges with the I-70
- 14 highway would then be used to travel to Copper Mountain (at the junction of the I-70 highway and
- 15 SH 91).







13.12Alternate Route 12 – Colorado Springs to Copper Mountain2via Hoosier Pass Tunnel (US 24/SH 9)

3 Alternate Route 12 (AR-12) would differ from AR-11 only in that a tunnel under Hoosier Pass would be

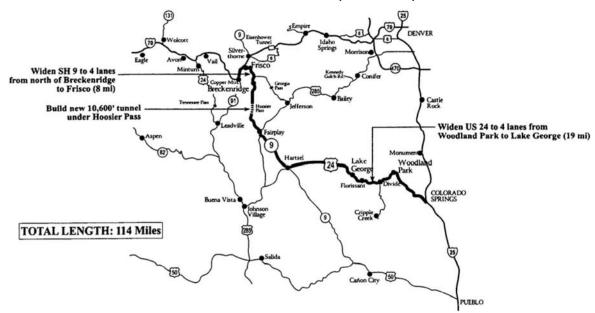
4 included. Unlike potential tunnels discussed relative to other alternate routes, preliminary field

5 observations indicated that a tunnel under Hoosier Pass would encounter unique soil problems and major

6 cost increases (**Figure 15**). A tunnel under Hoosier Pass has been identified for this alternate route.

- 7 Potential construction constraints have been reflected in a higher cost estimate.
- 8 9

Figure 15. Alternate Route 12 – Colorado Springs to Copper Mountain via Hoosier Pass Tunnel (US 24/SH 9)



3.13 Alternate Route 13 – Colorado Springs to Minturn via Buena 2 Vista (US 24)

3 Alternate Route 13 (AR-13) would use the entire length of US 24 between Colorado Springs and Minturn

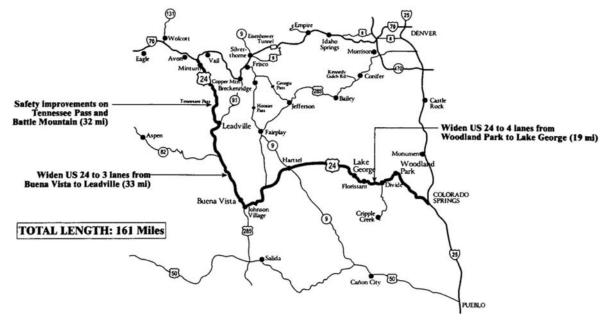
4 where it meets the I-70 highway at Dowd Canyon (Figure 16). This route would include improvements

5 west of Woodland Park and north of Buena Vista. Topographic constraints over Tennessee Pass and

- 6 Battle Mountain would restrict any widening to short segments of climbing lanes and safety
- 7 improvements.

8

Figure 16. Alternate Route 13 – Colorado Springs to Minturn via Buena Vista (US 24)



Alternate Route 14 – Colorado Springs to Copper Mountain 3.14 1 via Buena Vista (US 24/SH 91) 2

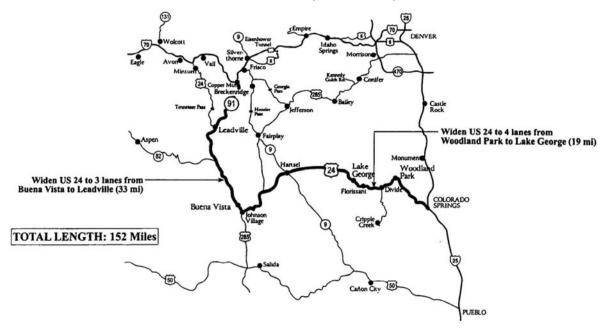
3 Alternate Route 14 (AR-14) would use a longer stretch of existing US 24 to make a different connection

4 to Summit County (Figure 17). The same upgrade of US 24 to a four-lane roadway as previously

5 described (AR-13) would be made between Woodland Park and Lake George. At Hartsel, the route would

- 6 continue on US 24 through Buena Vista with no widenings being made. North of Buena Vista, US 24
- 7 would be widened to three lanes to provide an uphill passing lane to Leadville. Between Leadville and
- 8 Copper Mountain, SH 91 traverses Fremont Pass. The road currently has a climbing lane on the steep 9
- sections of the pass, and no widening would be done on the remainder of SH 91, which is more level.
- 10 11

Figure 17. Alternate Route 14 – Colorado Springs to Copper Mountain via Buena Vista (US 24/SH 91)



Alternate Route 15 – Pueblo to Copper Mountain via Hoosier 3.15 1 Pass – Surface (US 50/SH 9) 2

3 Alternate Route 15 (AR-15) would follow US 50 west from Pueblo to its junction with SH 9 in the

4 vicinity of Royal Gorge west of Canyon City (Figure 18). At this point, the route would follow SH 9

5 through Hartsel, Fairplay, Breckenridge, and Frisco to reach the I-70 highway. The I-70 highway would 6 provide the final connection to Copper Mountain.

7 The segment of SH 9 over Hoosier Pass would be upgraded to three lanes to provide an uphill passing

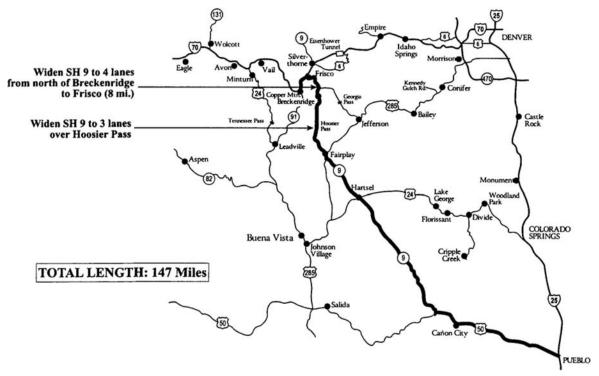
8 lane. Existing switchbacks on the north side of the pass are assumed to be straightened as much as

9 possible with this alternate route.





Figure 18. Alternate Route 15 – Pueblo to Copper Mountain via Hoosier Pass – Surface (US 50/SH 9)



Alternate Route 16 – Pueblo to Copper Mountain via Hoosier 3.16 1 Pass – Tunnel (US 50/SH 9) 2

3 Alternate Route 16 (AR-16) would follow US 50 west from Pueblo to its junction with SH 9 in the

4 vicinity of Royal Gorge west of Canyon City (Figure 19). At this point, the route would follow SH 9

5 through Hartsel, Fairplay, Breckenridge, and Frisco to reach the I-70 highway. The I-70 highway would

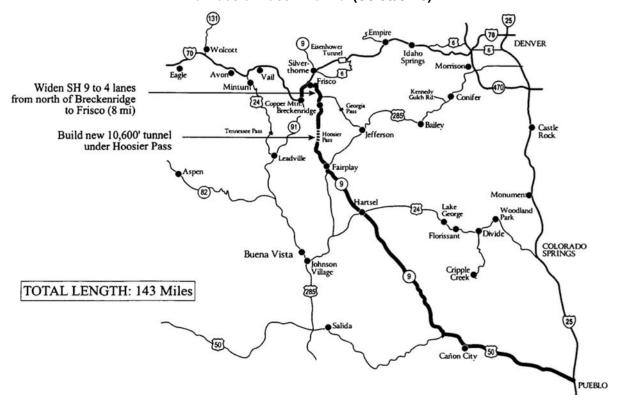
6 provide the final connection to Copper Mountain.

7 The segment of SH 9 between Breckenridge and Fairplay is assumed to include a tunnel under Hoosier 8 Pass.



10

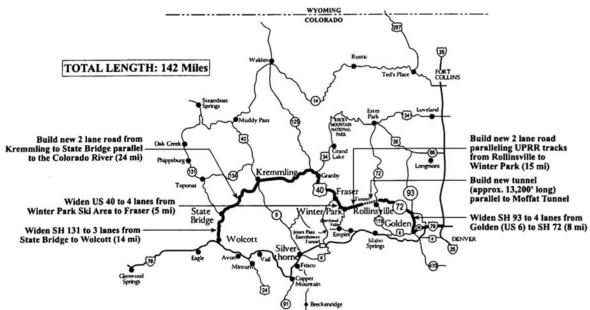
Figure 19. Alternate Route 16 – Pueblo to Copper Mountain via Hoosier Pass – Tunnel (US 50/SH 9)



13.17Alternate Route 17 – Denver to Winter Park via New Tunnel2Parallel to Moffat Tunnel (SH 58, SH 93, and SH 72) to Wolcott

Alternate Route 17 (AR-17) is the same route as Alternate Route 4. The route was re-considered during
 Level 2 screening under this new name.

5 Figure 20. Alternate Route 17 – Denver to Winter Park via New Tunnel Parallel to Moffat Tunnel 6 (SH 58, SH 93, and SH 72) to Wolcott



Section 4. The Alternative Routes Screening Process

2 4.1 Level 1 Screening

Evaluation of the seventeen Alternate Routes at Level 1 screening focused on criteria related to project
 purpose and need, including:

- 5 Mobility (ability to provide a competitive travel time advantage compared to the I-70 highway travelers);
- 7 Accessibility (proximity to current origins and destinations along the I-70 highway Corridor); and
- Travel market served (proximity to Denver Front Range communities, where the majority of the I-70 highway travel originates).
- 10 All of these criteria were used to determine the potential of these seventeen Alternate Routes to alleviate
- traffic on the I-70 highway such that no mobility improvements are needed to the I-70 highway. These
- 12 criteria, by the nature of the Level 1 screening process, were qualitative, with sufficient quantitative
- 13 support to justify the basic conclusions.
- 14 The Colorado Department of Transportation conducted a user survey on the I-70 highway to understand
- 15 where vehicles were coming from that were using the highway. The results are documented in the report

16 titled The I-70 User Study, Denver to Vail, Colorado, Summer 1999 and Winter 2000 Surveys (HNTB,

- 17 July 2000) and are summarized below.
- 18 The information was collected at three locations Idaho Springs, Frisco, and Vail. The project team
- reported the county of origin of the vehicles using the I-70 highway at each of these location. The
- 20 information is reported by the counties of residence in Colorado, and out-of-state travelers. **Table 1**
- 21 provides details for counties within four areas—Denver Front Range, Corridor Counties, South Front
- Range, and North Front Range—and out-of-state travelers. **Table 1** presents the average of the summer and winter percentages of vehicles at Idaho Springs, Frisco, and Vail from the four areas of residence.
- and winter percentages of vehicles at Idano Springs, Frisco, and Vall from the four areas of residence.
 Data from the I-70 highway User Study shown on **Table 1** demonstrate that the majority of travelers on
- the I-70 highway either reside in the Denver Front Range area, within the corridor communities, or are
- 26 from out of state.
- 27 Level 1 screening resulted in the following findings:
- 28 Alternate Routes 1, 4, 5, 6, 7, 8, and 10 between the Denver metropolitan area and the central 29 Rocky Mountains would involve travel distances more than a comparable vehicle trip along the 30 I-70 highway. In addition, travel times via all seven alternate routes would be greater than via the 31 I-70 highway during uncongested travel periods. These routes were eliminated from further 32 consideration because they would not provide suitable accessibility to the Corridor communities or the ability to constitute a viable alternative to the I-70 highway. Therefore, these alternatives 33 34 were not considered attractive enough to divert traffic from the I-70 highway and they were 35 therefore eliminated.
- Alternate Routes 2, 3, 11, 12, 13, 14, 15, and 16 would have a low percentage of travelers
 originating from the Front Range area and all were eliminated because they do not have the
 potential to divert any more than 3 to 4 percent of the traffic volume off the I-70 Mountain
 Corridor.
- Alternate Route 9 was carried forward for Level 2 screening because it was found that during peak travel periods, it may be able to provide competitive travel times with the I-70 Mountain Corridor.

	Summe	Summer 1999 Survey			2000 Surve	еу
		D	enver Front	Range Counties	a. ar	
Counties	Idaho Springs	Frisco	Vail	Idaho Springs	Frisco	Vail
Adams	4.7	3.3	2.1	3.6	2.3	1
Arapahoe	10.8	7.9	5.4	9.6	7.9	3.6
Boulder	6	5.3	3.1	6.8	5.4	2.4
Denver	19.8	15.8	12.2	20.7	20.6	10.9
Douglas	4.7	3	1.7	4	3.1	1.2
Jefferson	13.8	9.4	5.4	13.6	8.5	2.6
Total	59.8	44.7	29.9	58.3	47.8	21.7
Average of Summer and Winter Surveys	59.1	46.3	25.8			

Table 1. Percentage Vehicles by County of Residences

			Corrid	or C	ounties		
Counties	Idaho Springs	Frisco	Vail		Idaho Springs	Frisco	Vail
Clear Creek	1.9	0.6	0.2	1	3.5	0.4	0.1
Eagle	5.5	11	37.9		2.5	7.8	42.8
Garfield	1.2	3.2	2.7		1.1	2.5	2.2
Summit	4.9	3.5	1.4		2.8	3.9	1.1
Park	0.3	0.2	0.2		0.3	0.2	0.1
Lake	0.6	2.7	0.4		0.5	2.6	0.7
Grand	1.6	0.2	0.1		1.5	0.2	0.1
Gilpin	0.1	0.1	0		0.4	0.1	0.1
Pitkin	0.4	0.9	0.4		0.4	0.8	0.7
Total	16.5	22.4	43.3		13	18.5	47.9
Average of Summer and Winter Surveys	14.8	20.5	45.6				

		8	South Front I	Ran	ge Counties		
Counties	Idaho Springs	Frisco	Vail		Idaho Springs	Frisco	Vail
Pueblo	0.3	0.3	0.3		0.1	0.3	0.2
El Paso	2.8	3.1	2.6		2.5	3	2
Teller	0.1	0.1	0.1		0	0.1	0.1
Fremont	0.1	0.1	0		0.1	0.1	0
Total	3.3	3.6	3		2.7	3.5	2.3
Average of Summer and Winter Surveys	3.0	3.6	2.7				

	North Front Range Counties							
Counties	Idaho Springs	Frisco	Vail	Idaho Springs	Frisco	Vail		
Larimer	2.3	2.2	1.3	2.5	1.9	1		
Weld	1.1	1.4	0.7	1	0.9	0.5		
Total	3.4	3.6	2	3.5	2.8	1.5		
Average of Summer and Winter Surveys	3.5	3.2	1.8					

		١	Jorth Front F	Range Counties		
Origin	Idaho Springs	Frisco	Vail	Idaho Springs	Frisco	Vail
Out of State	10	16	16	19	21	22
Total	10	16	16	19	21	22
Average of Summer	44.5	40.5	40			
and Winter Surveys	14.5	18.5	19			

1 4.1.1 Analysis of Alternate Routes

- 2 In analyzing these alternate routes, they were divided into relatively homogenous segments (between
- 3 existing towns or major road junctions) to better reflect existing conditions and determine needed
- 4 improvements. This information for route segments is documented in the Appendix A. The technical
- 5 information includes traffic volumes, total miles, average speeds, travel times, congested speeds,
- 6 congested travel times, and information on existing and proposed laneage for each segment of the routes.
- 7 Certain segments have been recommended for upgrading to four lanes (which would include either a
- 8 depressed median approximately 30 feet wide or a narrow, barrier separated median in difficult terrain) or
- 9 to three lanes (to provide an uphill passing lane). Along segments of existing highways where no
- 10 widening is recommended, spot improvements would be made to improve safety or flatten out
- 11 particularly tight curves.

12 Travel Time Comparisons

- 13 **Table 2** summarizes the distance and travel time for each alternate route for comparison with the I-70
- 14 highway. Two travel time estimates were prepared; one for uncongested conditions and one for peak
- 15 period congested travel conditions. An examination of **Table 3** indicates:

16 17		Five of the 16 alternate routes provide a shorter travel distance when compared to the I-70 highway. These alternate routes are:
18		AR-2 Fort Collins to Wolcott via Kremmling
19		AR-11 Colorado Springs to Copper Mountain via Hoosier Pass (surface)
20		AR-12 Colorado Springs to Copper Mountain via Hoosier Pass Tunnel
21		• AR-15 Pueblo to Copper Mountain via Hoosier Pass (surface)
22		AR-16 Pueblo to Copper Mountain via Hoosier Pass Tunnel
23 24		Three of the 16 alternate routes result in travel time savings, relative to the I-70 highway, during uncongested travel periods. These routes are:
25		AR-12 Colorado Springs to Copper Mountain via Hoosier Pass Tunnel
26		• AR-15 Pueblo to Copper Mountain via Hoosier Pass (surface)
27		AR-16 Pueblo to Copper Mountain via Hoosier Pass Tunnel
28 29 30		The most noteworthy travel time difference occurs with AR-16. For this route, a trip will take approximately 21 minutes less than if the same trip was taken on the 1-70 highway. This is a 12.4 percent difference in travel time.
31 32	•	Five of the 16 alternate routes result in equal or reduced travel times relative to the I-70 highway, during congested travel periods. These routes are:
33		• AR-9 Denver to Copper Mountain via Georgia Pass Tunnel
34		• AR-11 Colorado Springs to Copper Mountain via Hoosier Pass (surface)
35		AR-12 Colorado Springs to Copper Mountain via Hoosier Pass Tunnel
36		• AR-15 Pueblo to Copper Mountain via Hoosier Pass (surface)
37		AR-16 Pueblo to Copper Mountain via Hoosier Pass Tunnel
38 39 40 41	less that travel t SH93,	ost noteworthy travel time difference occurs with AR-16. For this route, a trip will take 43 minutes on the same if the same trip was taken on the I-70 highway. This is a 19.3 percent difference in ime. Note that AR-17 Denver to Winter Park via New Tunnel Parallel to Moffat Tunnel (SH58, SH 72) to Wolcott was originally ARNF-4 and was reconsidered under this new name during
42	Screen	ing Level 2, which is discussed in Section 4.2.

Copper Mountain The I-70 Highway

Tunnels

Tunnel

Tunnel

Tunnel

Tunnel

AR-5—SH 72 via Moffat, Berthoud Pass and Jones Pass

AR-7—SH 9? via Jones Pass

AR-8-US 285 via Hoosier Pass

AR-9-US 285 via Georgia Pass

AR-11-US 24 via Hoosier Pass

AR-12-US 24 via Hoosier Pass

AR-13—US 24 via Buena Vista

AR-15-US 50 via Hoosier Pass

AR-16—US 50 via Hoosier Pass

The I-70 Highway

The I-70 Highway

The I-70 Highway

1

Denver

Denver

Colorado

Springs

Pueblo

Minturn

Minturn

Copper Mountain

Key to Abbreviations/Acronyms: AR = Alternate Route

AR-14-US 24 via Buena Vista

Colorado Springs Copper Mountain The I-70 Highway

AR-10—US 285 via Buena Vista

Origin	Destination	n Route	Distance (miles)	Travel Time (Minutes)	
Fort Collins	Wolcott	The I-70 Highway	173	154	
		AR-1—SH 14 via Walden	225	267	
		AR-2—US 34 via Kremmling	140	172	
Fort Collins	Copper Mount	ain The I-70 Highway	135	119	
AR-3—US 34	via Kremmling		149	178	
Denver	Wolcott	The I-70 Highway	117	109	
		AR-4—SH 72 via Moffat Tunnel	142	197	
		AR-6—the I-70 highway to US 40 via Berthoud Pass Tunnel	142	162	

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Table 2. Comparative Distances and Travel Times

Congested **Travel Time**

(Minutes) 206

> 323 211

171

218 165

244

211

130

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185

130

152

268

184 182

166

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244

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196

	Table 5. Level 1 Alternatives Analysis Screening Results						
	Alternate Route	Level 2 Screening Results					
1	Fort Collins to Wolcott via Walden (SH 14 and SH 131)	Eliminated since travel time is not competitive with the congested I-70 highway. Low percentage (1.9 percent) of travelers originating from the area does not meaningfully reduce the I-70 highway congestion.					
2	Fort Collins to Wolcott via Kremmling (US 34)	Eliminated due to the low percentage (1.9 percent) of travelers originating from the area.					
3	Fort Collins to Copper Mountain via Kremmling (US 34 and SH 9)	Eliminated due to the low percentage (1.9 percent) of travelers originating from the area.					
4	Denver to Wolcott via Moffat Tunnel (SH 72, US 40, and US 34)	Eliminated since travel time is not competitive with the congested I-70 highway.					
5	Denver to Copper Mountain via Moffat, Berthoud, and Jones Pass Tunnels (SH 72 and SH 9)	Eliminated since travel time is not competitive with the congested I-70 highway.					
6	Denver to Wolcott via Berthoud Pass Tunnel (US 40 and US 34)	Eliminated since travel time is not competitive with the congested I-70 highway.					
7	Denver to Copper Mountain via Jones Pass Tunnel (SH 9)	Eliminated since travel time is not competitive with the congested I-70 highway.					
8	Denver to Copper Mountain via Hoosier Pass (surface) (US 285 and SH 9)	Eliminated since travel time is not competitive with the congested I-70 highway.					
9	Denver to Copper Mountain via Georgia Pass Tunnel (US 285)	Advanced to Level 2 screening.					
10	 Denver to Minturn via Buena Vista (US 285 and US 24) 	Eliminated since travel time is not competitive with the congested I-70 highway.					
11	Colorado Springs to Copper Mountain via Hoosier Pass (surface) (US 24 and SH 9)	Eliminated due to the low percentage (2.7 percent) of travelers originating from the area.					
12	Colorado Springs to Copper Mountain via Hoosier Pass Tunnel (US 24 and SH 9)	Eliminated due to the low percentage (2.7 percent) of travelers originating from the area.					
13	Colorado Springs to Minturn via Buena Vista (US 24)	Eliminated due to the low percentage (2.7 percent) of travelers originating from the area.					
14	Colorado Springs to Copper Mountain via Buena Vista (US 24 and SH 91)	Eliminated due to the low percentage (2.7 percent) of travelers originating from the area. Travel time not competitive with the congested I-70 highway.					
15	Pueblo to Copper Mountain via Hoosier Pass (surface) (US 50 and SH 9)	Eliminated due to the low percentage (0.3 percent) of travelers originating from the area.					
16	Pueblo to Copper Mountain via Hoosier Pass Tunnel (US 50 and SH 9)	Eliminated due to the low percentage (0.3 percent) of travelers originating from the area.					

Table 3. Level 1 Alternatives Analysis	Screening Results
--	--------------------------

2 4.2 Level 2 Screening

- 3 Before initiating Level 2 screening, the project team reconsidered AR-4 under a new name, Alternative
- 4 Route 17 (AR-17) Denver to Winter Park via New Tunnel Parallel to Moffat Tunnel (SH58, SH93, and
- 5 SH72) to Wolcott. This route was reconsidered because the newly-developed travel demand model
- 6 provided additional information for evaluation.
- 7 The two alternate routes (AR-9 and AR-17) were analyzed for Level 2 Screening. The criteria used to
- 8 evaluate these alternatives are: travel time, alternate routes costs, and potential impacts to environmental
 9 resources. The results of the screening analyses are presented below.
 - I-70 Mountain Corridor PEIS

1 4.2.1 Alternate Route 9 – Screening Analysis

2 Alternative Route 9 was eliminated from further consideration due to the environmental conflicts of

3 developing a new route to Breckenridge and an improved US 285 in Jefferson and Park Counties, with a

4 lack of travel time advantage. The new alignment portion of Alternate Route 9 through Park County

5 would traverse the area near Jefferson and Georgia Pass, which contains the highest concentration of

6 natural and cultural resources in southern Park County located within a portion of the South Park National

- 7 Heritage Area (13.3 miles of the alternate are in the South Park Heritage area). Of the 13.3 miles,
- 4.3 miles are improvements to US 285 and 9.0 miles are new construction. Natural resources in the area
 include an extensive fen that would be unavoidable in creating a new Georgia Pass tunnel alignment. This
- 9 include an extensive fen that would be unavoidable in creating a new Georgia Pass tunnel alignment. This
 10 alternate route was also eliminated because of the extraordinary costs associated with building a new
- 11 10,600 foot 2-lane tunnel through Georgia Pass (\$520 million in year 2001 dollars).
- 12 Alternate Route 9 would provide an alternative to the I-70 highway for access to Summit County;
- however, the travel time comparisons to using the I-70 highway do not show an advantage to using this
- 14 alternate route. Travel time comparisons provided in **Table 2** show that the 105-mile trip using Alternate

15 Route 9 would take 118 minutes (1 hour and 58 minutes) during uncongested periods, and 130 minutes (2

hours and 10 minutes) during congested periods. By comparison, the 79-mile trip via the I-70 highway to

17 Copper Mountain would take 74 minutes (1 hour and 14 minutes) during uncongested periods, and

18 130 minutes (2 hours and 10 minutes) during congested periods.

19 Sixteen acres of important wetland/fen complexes in the Jefferson area are affected by widening US 285.

- 20 The wetlands at Jefferson and Guernsey Creeks contain extremely rich fens with a biodiversity rank of B2
- 21 (very highly significant) (Sanderson, et al, 1996). The 16 acres of fens are shown in Figure 5.
- 22 Widening through this US 285 area has the potential to affect Kenosha Pass Summit, a property listed on

23 the State Register of Historic Properties. Four Historic ranches in the Jefferson area have the potential to

be affected by widening US 285, including the Wahl Ranch which is listed on the National Register of

25 Historic Places. Widening also has the potential to affect the nationally listed Jefferson Denver South

Park and Pacific Railroad Depot located at the junction of US 285 and City Road 35. See Figure 6,

27 Proposed Alternate Route 9, Potential Wildlife Habitat Impacts in **Appendix B**.

- 28 Twenty-two miles of new 2-lane road northwest from Jefferson through Georgia Pass to north of
- 29 Breckenridge would affect 28 acres of lynx habitat (on the White River National Forest); 91 acres of elk
- 30 key habitat; and 133 acres of deer key habitat. See **Figure 5**, Proposed Alternate Route 9, Potential

31 Wildlife Habitat Impacts in **Appendix B**.

- 32 The new 2-lane road affects 3,500 feet of streams; 60 acres of United States Forest Service Land, 3 acres
- of which are forest service designated roadless areas; and almost 6 acres of State Wildlife Areas. Other
- 34 environmental resources affected include 8 acres of State land, and 172 acres of private land. See Figure
- 35 6, Proposed Alternate Route 9: Potential Stream and Land Impacts in **Appendix B**.

1 4.2.2 Alternate Route 17 – Screening Analysis

2 Alternative Route 17 was eliminated from further consideration due to the cost of developing a new

3 tunnel (\$650 million in year 2001 dollars) with a lack of travel time effectiveness. Alternate Route 17

4 would provide an alternative to the I-70 highway for access to Eagle County; however, the travel time

5 comparisons to using the I-70 highway do not show an advantage to using this alternate route. Travel time

6 comparisons indicate that the 142-mile trip using Alternate Route 17 would take 197 minutes (3 hours

- and 17 minutes) during uncongested periods, and 244minutes (4 hours and 9 minutes) during congested
- periods. By comparison, the 117-mile trip via the I-70 highway to Wolcott would take 109 minutes (1
 hour and 49 minutes) during uncongested periods, and 165 minutes (2 hours and 45 minutes) during
- 9 nour and 49 minutes) during uncongested periods, and 165 minutes (2 nours and 45 minutes) during
- 10 congested periods.

4.3 Summary of Level 2 Screening and Public Coordination

12 The analysis showed that neither alternate route would remove enough traffic from the I-70 highway to

13 improve travel conditions and avoid the need to pursue mobility enhancements to the I-70 highway. In

addition, the improvements to the existing roadways and the new roads and tunnels required for

alternative routes would result in large social and environmental impacts, as well as high costs due to

16 tunneling.

17 At the beginning of Level 2 screening, the information on alternate routes was presented at public

18 workshops in January 2001 and at Advisory Committee meetings in February 2001, with the

19 recommendation that alternate routes be eliminated. Attendees at each forum endorsed this

- 20 recommendation. Results of Level 2 screening were announced in the June 2001 newsletter.
- 21 No alternate routes were advanced for further consideration in the PEIS.

22 Section 5. References

23 Felsberg Holt & Ullevig. 2000. Description of Alternate Highway Routes Report. June.

- HNTB. 2000. *The I-70 User Study, Denver to Vail, Colorado, Summer 1999 and Winter 2000 Surveys.*July.
- 26 John Sanderson and Margaret March (Colorado Natural Heritage Program). 1996. Extreme Rich Fens of
- 27 South Park, Colorado: Their Distribution, Identification, and Natural Heritage Significance. Prepared
- for Park County, the Colorado Department of Natural Resources and the US Environmental Protection
- 29 Agency.

- 1 Two appendices support the Alternate Routes Technical Report:
- 2
- Appendix A provides operational details about the segments of the alternate routes contained in this
 technical report. The data were developed in 2000 as part of the initial study of alternate routes and
 were used to support the screening of these alternatives based on operational characteristics. They are
- 6 timely to the screening decisions that occurred during this timeframe.
- 7 Appendix B contains details about the environmental impacts associated with Alternate Route 9.
- 8 Analysis of impacts from this alternate route was conducted in the second level of screening, which
- 9 was also conducted in 2000 concurrent with the data collection.

Appendix A. Alternate Route Segment Data

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Alternative Route Segment Data													
Route	Highway	From	То	ADT Range (1000s)	Total	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Fort Collins to Wolcott via Walden													
AR-1	SH 14	1-25	US 287	12-27	4	35	7	30	8	2	2	0	4
	US 287	US 287	Ted's Place	5-20	9	45	12	35	15	2	2	0	9
	SH 14	Ted's Place	East Of Rustic	1-2	25	40	38	24	60	2	2	0	25
	SH 14	East of Rustic	Walden	1	63	55	69	45	84	2	3	63	0
	SH 14	Walden	US 40	1	34	55	37	50	41	2	2	0	34
	US 40	US 40	SH 131	2-3	21	55	23	50	25	2	2	0	21
	SH 131	SH 131	State Bridge	1-3	55	50	66	45	73	2	2	0	55
	SH 131	State Bridge	I-70/Wolcott	12-28	14	55	15	50	17	2	3	14	0
Total			1 C ACCOUNTRACTORNE		225		267		323				
Via I-70					173		154		206				
Fort Collins to Wolcott via Kremmling													
AR-2	I-25	SH 14	US 34	27-43	12	75	10	65	11	2	2	0	0
	US 34	US 34	Estes Park	1-20	34	40	51	30	68	2	2	0	34
	US 34	Estes Park	Grand Lake	new	14	50	17	40	21	0	2	0	0
	US 34	Grand Lake	Granby	3-4	15	50	18	40	23	2	2	0	15
	US 34	Granby	Kremmling	2-4	27	55	29	45	36	2	2	0	27
	new	Kremmling	State Bridge	new	24	45	32	40	36	0	2	24	0
	SH 131	State Bridge	I-70/Wolcott	12-28	14	55	15	50	17	2	3	14	0
Total					140		172		212				
Via I-70					173		154		206				
Fort Collins to Copper Mountain via Kremmling													
AR-3	I-25	SH 14	US 34	27-43	12	75	10	65	11	2	2	0	0
	US 34	US 34	Estes Park	1-20	34	40	51	30	68	2	2	0	34
	US 34	Estes Park	Grand Lake	new	14	50	17	40	21	0	2	0	0
	US 34	Grand Lake	Granby	3-4	15	50	18	40	23	2	2	0	15
	US 34	Granby	Kremmling	2-4	27	55	29	45	36	2	2	0	27
	SH 9	Kremmling	Silverthorne	3-21	37	50	44	45	49	2	3	37	0
	I-70	Silverthome	Copper Mountain	21-28	10	65	9	60	10	4	4	0	0
Total			Sopper mountain		149		178		218				
Via I-70					135		119		171				
					100	F	1 .17				· / D		·

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Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	
Denver to Wolcott via Moffat Tunnel													
AR-4	I-70	I-25	SH 58	77-128	8	60	8	55	9	6	6	0	0
	SH 58	I-70	Golden	11-19	5	55	5	50	6	2	2	0	0
	SH 93	Golden	SH 72	15-20	8	45	11	40	12	2	4	19	0
	SH 72	SH 93	SH 119	1-4	19	25	46	15	76	2	2	0	19
	SH 119	SH 72	Rollinsville	3	2	35	3	25	5	2	2	0	2
	new	Rollinsville	Winter Park	new	15	45	20	40	23	0	2	12	0
	US 40	Winter Park	Fraser	6-7	5	55	5	50	6	2	4	5	0
	US 40	Fraser	Granby	5-8	15	55	16	50	18	2	2	0	15
	US 34	Granby	Kremmling	2-4	27	45	36	45	36	2	2	0	27
	new	Kremmling	State Bridge	new	24	45	32	40	36	0	2	24	0
	SH 131	State Bridge	I-70/Wolcott	12-28	14	55	15	50	17	2	3	14	0
Total					142		197		244				
Via I-70					117		109		165				

Total	116	169	230
Via I-70	79	74	130

Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Denver to Wolcott via Berthoud Pass Tunnel													
AR-6	1-70	I-25	C-470	60-139	14	60	14	55	15	4-8	4-8	0	0
	I-70	C-470	US 6	30-59	15	65	14	60	15	6	6	0	0
	I-70	US 6	US 40/Empire	30-34	12	65	11	20	36	4	4	0	0
	US 40	US 40/Empire	Winter Park	4-7	16	50	19	30	32	2	2	0	16
	US 40	Winter Park	Fraser	6-7	5	55	5	50	6	2	4	5	0
	US 40	Fraser	Granby	5-8	15	55	16	50	18	2	2	0	15
	US 34	Granby	Kremmling	2-4	27	45	36	45	36	2	2	0	27
	new	Kremmling	State Bridge	new	24	45	32	40	36	0	2	24	0
k.	SH 131	State Bridge	I-70/Wolcott	12-28	14	55	15	50	17	2	3	14	0
Total					142	(F)	162		211				
Via I-70					117	17 million and 18	109	5	165				
Denver to Copper Mountain via Jones Pass Tunnel													
AR-7	I-70	I-25	C-470	60-139	14	60	14	55	15	4-8	4-8	0	0
	1-70	C-470	US 6	30-59	15	65	14	60	15	6	6	0	0
	1-70	US 6	US 40/Empire	30-34	12	65	11	20	36	4	4	0	0
	US 40	US 40/Empire	Berthoud Falls	5-7	9	50	11	30	18	2	2	0	1-2
	new	Berthoud Falls	Ute Pass Road	new	18	45	24	40	27	0	2	16	8-10
	new	Ute Pass Road	SH 9	new	8	35	14	30	16	0	2	8	8-10
	SH 9	New Road	Silverthorne	3-22	13	50	16	45	17	2	3	13	4-6
	I-70	Silverthorne	Copper Mountain	21-28	10	65	9	60	10	4	4	0	0
Total					99		113		154				
Via I-70					79		74		130				

Alternative Route Segment Data													
Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Denver to Copper Mountain via Hoosier Pass													
AR-8	1-70	Jct. I-25/I-70	Jct. I-70/C-470	60-139	14	60	14	55	15	4-8	4-8	0	0
	C-470	Jct. I-70/C-470	Jct. C-470/US 285	45-54	6	65	6	60	6	4	4	0	0
	US 285	Jct. C-470/US 285	Kennedy Gulch Rd.	18-25	9	50	11	45	12	4	4	0	9
	US 285	Kennedy Gulch Rd.	Bailey	5-16	19	55	21	50	23	2	4	19	0
	US 285	Bailey	Jefferson	3-5	23	55	25	50	28	2	4	23	0
	US 285	Jefferson	Fairplay	2.5-3	16	55	17	50	19	2	2	0	16
	SH 9	Fairplay	Breckenridge	3-7	21	40	32	30	42	2	3	21	0
	SH 9	Breckenridge	Breckenridge	7-12	2	25	5	5	24	2	2	0	2
	SH 9	Breckenridge	Frisco	12-19	8	50	10	50	10	2	4	8	0
	1-70	Frisco	Copper Mountain	20	7	65	6	65	6	4	4	0	0
Total					125		147		185				
Via 1-70					79		85		130				
Denver to Copper Mountain via Georgia Pass Tunnel													
AR-9	1-70	1-25	C-470	60-139	14	60	14	55	15	4-8	4-8	0	0
	C-470	I-70	US 285	45-54	6	65	6	60	6	4	4	0	0
	US 285	C-470	Kennedy Gulch Rd.	18-28	9	50	11	45	12	4	4	0	9
	US 285	Kennedy Gulch Rd.	Bailey	5-16	19	55	21	50	23	2	4	19	0
	US 285	Bailey	Jefferson	3-5	23	55	25	50	28	2	4	23	0
	new	Jefferson	Tiger Road	new	20	45	27	40	30	0	2	18	0
	SH 9	Tiger Road	Frisco	14-19	7	55	8	50	8	2	4	0	7
	I-70	Frisco	Copper Mountain	20	7	65	6	55	8	4	4	0	0
Total					105		118		130				
Via I-70					79		74		130				

Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Denver to Minturn via Buena Vista													
AR-10	I-70	I-25	C-470	60-139	14	60	14	55	15	4-8	4-8	0	0
	C-470	I-70	US 285	45-54	6	65	6	60	6	4	4	0	0
	US 285	C-470	Kennedy Gulch Rd.	18-25	9	50	11	45	12	4	4	0	0
	US 285	Kennedy Gulch Rd.	Bailey	5-16	19	55	21	50	23	2	4	19	0
	US 285	Bailey	Jefferson	3-5	23	55	25	50	28	2	4	23	0
	US 285	Jefferson	Fairplay	2.5-3	16	55	17	50	19	2	2	0	16
	US 285	Fairplay	Johnson Village	2-3.5	35	55	38	50	42	2	2	0	35
	US 24	Johnson Village	Buena Vista	8-11	3	35	5	25	7	2	2	0	3
	US 24	Buena Vista	Leadville	3-6	33	50	40	50	40	2	3	33	0
	US 24	Leadville	SH 91	5-12	2	20	6	10	12	2	2	0	2
	US 24	SH 91	I-70/Minturn	2-8	32	40	48	30	64	2	2	0	32
Total					192		231		268				
Via I-70					103]	97		152				
Colorado Springs to Copper Mountain via Hoosier Pass													
AR-11	US 24	1-25	Woodland Park	23-35	19	45	25	40	29	4	4	0	19
	US 24	Woodland Park	Lake George	3-6	19	55	21	55	21	2	4	19	0
	US 24	Lake George	Hartsel	2-3	26	65	24	45	35	2	2	0	26
	SH 9	Hartsel	Fairplay	1-2	16	65	15	65	15	2	2	0	16
	SH 9	Fairplay	Breckenridge (s)	3-7	21	40	32	30	42	2	3	21	0
	SH 9	Breckenridge (s)	Breckenridge (n)	7-12	2	25	5	5	24	2	2	0	2
	SH 9	Breckenridge (n)	Frisco	12-19	8	50	10	50	10	2	4	8	0
	1-70	Frisco	Copper Mountain	20	7	65	6	65	6	4	4	0	0
Total					118		138		182	-			
Via I-70					144		131		184				

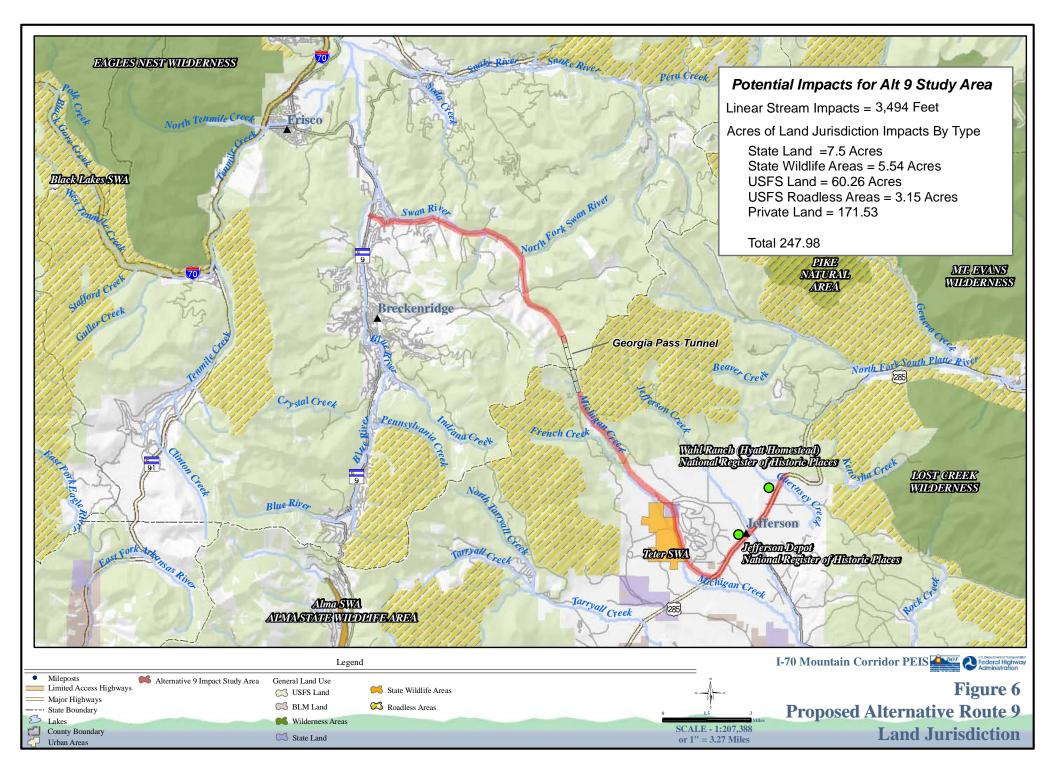
Alternative Route Segment Data													
Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Colorado Springs to Copper Mtn via Hoosier Pass Tunnel													
AR-12	US 24	I-25	Woodland Park	23-35	19	45	25	40	29	4	4	0	19
	US 24	Woodland Park	Lake George	3-6	19	55	21	55	21	2	4	19	0
	US 24	Lake George	Hartsel	2-3	26	65	24	45	35	2	2	0	26
	SH 9	Hartsel	Fairplay	1-2	16	65	15	65	15	2	2	0	16
	SH 9	Fairplay	Breckenridge (s)	3-7	17	45	23	40	26	2	2	0	0
	SH 9	Breckenridge (s)	Breckenridge (n)	7-12	2	25	5	5	24	2	2	0	2
	SH 9	Breckenridge (n)	Frisco	12-19	8	50	10	50	10	2	4	8	0
	1-70	Frisco	Copper Mountain	20	7	65	6	65	6	4	4	0	0
Total					114		129		166				
Via I-70					144		131		184				
Colorado Springs to Minturn via Buena Vista													
AR-13	US 24	I-25	Woodland Park	20-35	19	45	25	40	29	4	4	0	19
	US 24	Woodland Park	Lake George	3-6	19	55	21	55	21	2	4	19	0
	US 24	Lake George	Hartsel	2-3	26	65	24	45	35	2	2	0	26
	US 24	Hartsel	Johnson Village	2-5	27	65	25	45	36	2	2	0	27
สาขางกลายกลายกลายกลายกลายกลายกลายกลายกลายกลาย	US 24	Johnson Village	Buena Vista	8-11	3	35	5	25	7	2	2	0	3
	US 24	Buena Vista	Leadville	3-6	33	50	40	50	40	2	3	33	0
	US 24	Leadville	SH 91	5-12	2	20	6	10	12	2	2	0	2
	US 24	SH 91	I-70/Minturn	2-8	32	40	48	30	64	2	2	0	32
Total					161		194		244				
Via I-70					168		153		206				

Alternative Route Segment Data													
Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Miles of Highway Safety Upgrades
Colorado Springs to Copper Mountain via Buena Vista													
AR-14	US 24	I-25	Woodland Park	20-35	19	45	25	40	29	4	4	0	19
	US 24	Woodland Park	Lake George	3-6	19	55	21	55	21	2	4	19	0
	US 24	Lake George	Hartsel	2-3	26	65	24	45	35	2	2	0	26
	US 24	Hartsel	Johnson Village	2-5	27	65	25	45	36	2	2	0	27
	US 24	Johnson Village	Buena Vista	8-11	3	35	5	25	7	2	2	0	3
	US 24	Buena Vista	Leadville	3-6	33	50	40	50	40	2	3	33	0
	US 24	Leadville	SH 91	5-12	2	20	6	10	12	2	2	0	2
	SH 91	US 24	Copper Mountain	5-6	23	55	25	40	35	2	2	0	23
Total					152		171		215				
Via I-70					144		131		184				
Pueblo to Copper Mountain via Hoosier Pass													
AR-15	US 50	1-25	SH 45	30-35	3	45	4	40	5	4	4	0	0
	US 50	SH 45	SH 115 (n)	10-25	22	55	24	45	29	4	4	0	0
	US 50	SH 115 (n)	Canon City	20-25	11	65	10	50	13	4	4	0	0
	US 50	Canon City	US 50	10-12	10	65	9	65	9	2	2	0	0
	SH 9	US 50	Hartsel	1-2	47	65	43	65	43	2	2	0	0
	SH 9	Hartsel	Fairplay	1-2	16	65	15	65	15	2	2	0	16
	SH 9	Fairplay	Breckenridge	3-7	21	40	32	30	42	2	3	21	0
	SH 9	Breckenridge	Breckenridge	7-12	2	25	5	5	24	2	2	0	2
	SH 9	Breckenridge	Frisco	15-20	8	50	10	5	10	2	4	8	0
	I-70	Frisco	Copper Mountain	20	7	65	6	65	6	4	4	0	0
Total					147		158		196				
Via I-70					186		170		223				

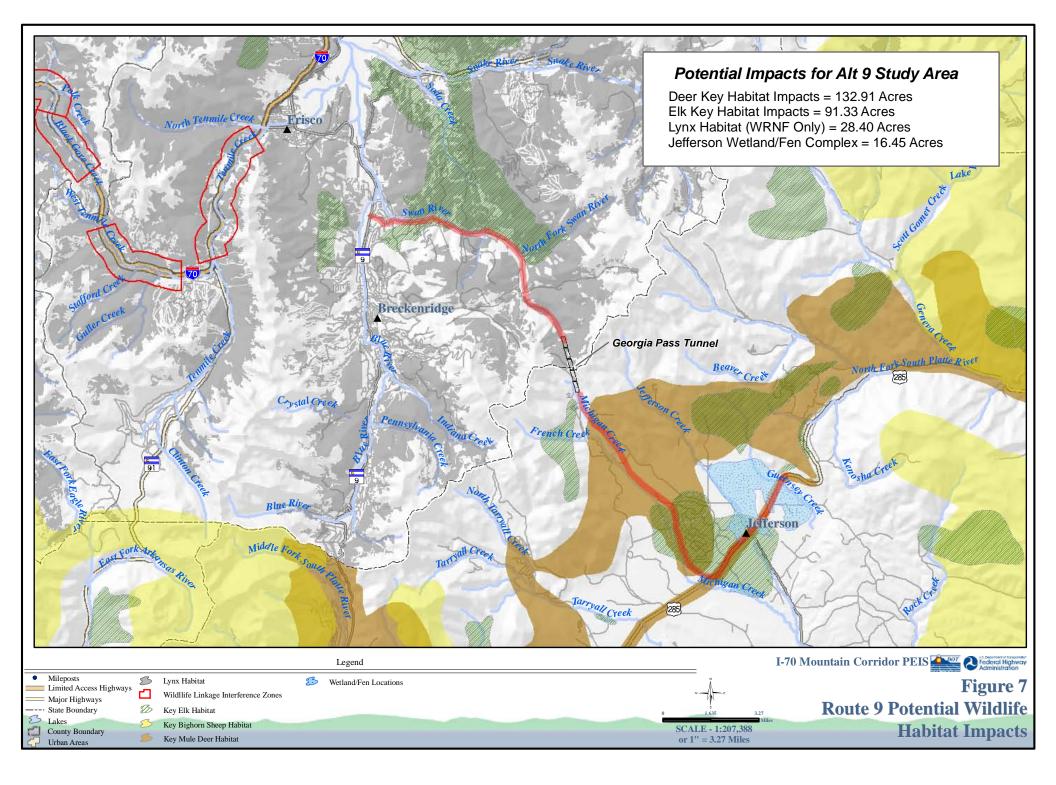
Alternative Route Segment Data													
Route	Highway	From	То	ADT Range (1000s)	Total Miles	Avg Speed (mph)	Travel Time (min)	Cong. Speed (mph)	Cong. Travel Time (min)	Exist Laneage	Prop. Laneage	Miles of New Highway/ Upgrades	Highway
Pueblo to Copper Mountain via Hoosier Pass Tunnel													
AR-16	US 50	I-25	SH 45	30-35	3	45	4	40	5	4	4	0	0
	US 50	SH 45	SH 115 (n)	10-25	22	55	24	45	29	4	4	0	0
	US 50	SH 115 (n)	Canon City	20-25	11	65	10	50	13	4	4	0	0
	US 50	Canon City	US 50	10-12	10	65	9	65	9	2	2	0	0
	SH 9	US 50	Hartsel	1-2	47	65	43	65	43	2	2	0	0
	SH 9	Hartsel	Fairplay	1-2	16	65	15	65	15	2	2	0	16
	SH 9	Fairplay	Breckenridge (s)	3-7	17	45	23	40	26	2	0	0	0
	SH 9	Breckenridge (s)	Breckenridge (n)	7-12	2	25	5	5	24	2	2	0	2
	SH 9	Breckenridge (n)	Frisco	15-20	8	50	10	5	10	2	4	8	0
	I-70	Frisco	Copper Mountain	20	7	65	6	65	6	4	4	0	0
Total					143		149		180				
Via I-70					186		170		223				

Appendix B. Alternate Route 9 Resource Impact Maps

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Appendix J TranSystems I-70 Mountain Corridor Programmatic Environmental Impact Statement Level One Screening Process October 2000 This page intentionally left blank.

I-70 MOUNTAIN CORRIDOR PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

LEVEL ONE SCREENING PROCESS

October 2000

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Appendix A – Summary Screening Table

Appendix B- Operational Characteristics of Transit Alternatives

INTRODUCTION

The Colorado Department of Transportation (CDOT), in consultation with the Federal Highway Administration (FHWA), has decided to prepare a Programmatic Environmental Impact Statement (PEIS) for the I-70 Mountain Corridor in order to take a broad view of transportation-related issues and alternatives solutions for I-70 between C-470 and Glenwood Springs.

The I-70 Mountain Corridor Major Investment Study commissioned by CDOT projected increases in congestion and other mobility problems over a 20-year period. The PEIS approach enables these transportation problems to be addressed as a system. The transportation elements being addressed in the I-70 Mountain Corridor PEIS include transportation management, fixed guideway transit, rubber tire transit, highway and interchange improvements, alternate routes, and aviation.

The overall I-70 PEIS process involves a progression of steps: Scoping, Alternatives Analysis, Environmental Analysis, and PEIS Preparation. The Scoping process identifies issues and public and agency comments on alternatives. Through two levels of the Alternative Analysis, alternatives will procedurally be selected from within families for environmental impact assessment and comparison of the alternatives. Alternative(s) from the families will progress to the Environmental Analysis stage of the study where further refinement and packaging of single modes into multi-modal combinations will occur for an investigation of environmental impacts. Some alternatives may be evaluated as stand alone options. PEIS preparation provides documentation and disclosure of direct, indirect and cumulative environmental impacts and mitigation for the selected action and other alternatives.

Screening and Evaluation Process

The alternatives analysis component of the PEIS includes two levels of screening to be conducted based on an analysis of issues and alternatives identified through scoping. This document focuses on the initial level of analysis (Level One Screening). Level One Screening focused on criteria related to the purpose and need for the project. Related screening criteria include: 1) Meaningful reduction in congestion (increase mobility) and 2) improved safety in the I-70 Mountain Corridor. The screening process for each alternative employed these criteria in general, however, the criteria were modified as appropriate to reflect alternative-specific issues. This stage of the analysis developed alternatives within individual modes of transportation (i.e., transportation management, fixed guideway transit, rubber tire transit, highway and interchange elements, alternate routes, and aviation).

The results of the Level 1 Screening are summarized in Appendix B. This table provides a complete list of the alternatives within each family, Level 1 screening criteria and results. All of the alternatives within the highway and interchange element family and the transportation management family passed through the Level 1 screening process. The

following sections summarize results for the transit alternatives, alternate routes, and aviation families.

It is important to remember that in both the first and second level screening processes, options are to be evaluated only <u>within a family</u> and not among or against options in other families. Once options within the families are selected during second level screening and move to the PEIS analysis, intermodal evaluation will take place utilizing cross-modal measures to ensure the most effective and efficient combination of recommended options is selected.

TRANSIT ALTERNATIVES

A number of transit alternatives exist which can be evaluated regarding their ability to contribute to improved mobility in the I-70 Mountain Corridor between C-470 and Dotsero. These transit alternatives consist of various forms of rubber-tired, rail based, and other promising technologies for ground transportation. These alternatives each have a number of implementation options that represent a variety of vehicle sizes and types, guideway technologies, line configurations, propulsion types, and resulting system performance capabilities. These differences greatly affect the initial capital costs to construct the various systems, the unit cost of the vehicles, the number of vehicles required to move a given number of people or volume of goods, the safety of the passengers and the public, and the costs to operate and maintain the systems. These differences, in turn, affect the ultimate capacity of any proposed system, the overall running time between end points, the energy consumption per passenger, and the environmental impacts of the system, and ultimately their suitability to operated effectively in a given environment.

The purpose of examining transit alternatives is to determine whether any ground transportation technologies that either currently exist or show significant promise of being developed in the near future, could become a meaningful component to address the overall I-70 Mountain Corridor capacity and mobility needs identified in the programmatic Environmental Impact Statement.

Description of Transit Options

Potential reasonably available (defined as either existing and in service or promising as characterized by the existence of a prototype or substantive research) public transit applications were culled from various sources within the Transportation Research Board (TRB) of the National Academy of Sciences, Jane's World Railways, Jane's Urban Transport Systems, The American Public Transportation Association (APTA), the Association of American Railroads (AAR), the Federal Transit Administration (FTA), and the Federal Railroad Administration (FRA). Additional promising technologies were identified by the technology proponents and in most cases have not been tested or verified under real-world operating conditions.

Once the universe of potential applications had been identified, an assessment was conducted to assure that they were capable of operation safely in the corridor considering the unique physical and environmental demands present. Given the nature and length of the I-70 Mountain Corridor, only fixed guideway and/or rubber tired system that utilize enclosed, lighted, and climate controlled passenger compartments are included in the description of reasonable alternatives presented for consideration. Additionally, potential systems must be capable of traversing the 127 mile corridor from C-470 to Dotsero in less than 3.5 hours (an average speed of about 35 miles per hour) in order to be considered a reasonable alternative.

This initial prescreening eliminated a number of short haul or specialty systems that would clearly be inappropriate in the corridor, including escalators, moving sidewalks, funiculars, aerial tramways, and gondolas. As a result, 31 reasonable technology options have been identified that meet the minimum requirements for operation in the corridor. These 31 options can be consolidated into five general groups having similar characteristics and attributes. These five transit groups are:

- Rubber tired transit (bus based systems)
- Automated guideway transit
- Rail transit
- Passenger railroads
- Advanced guideway systems

These five groups, and the 31 options within these groups, will be identified and generally described in the following section. Presentation of these options against the defined screening criteria will also be discussed later in this report.

The types of transit applications that could be utilized in the I-70 Mountain Corridor can be generally categorized into two major technology systems, rubber tired transit (buses) and fixed guideway transit. Each application has a number of options involving the type of propulsion, operational characteristics, and physical attributes. Within the rubber tired transit category, four major groups with fifteen options have been identified. Within the fixed guideway category, four major groups with sixteen options have been identified. Descriptions of these groups and options follow:

Rubber Tire Transit (Bus based)

Options to utilize buses in the I-70 Mountain corridor consist of a number of separate configurations of infrastructure and vehicles. In this report the term "bus" is defined to mean any self-powered vehicle designed for commercial use and capable of operating on state roads carrying in excess of six passengers. Fuel may be diesel, gasoline, compressed natural gas (CNG), propane, or other available alternate fuels. Buses using electric propulsion are referred to as Electric Trolley Buses (ETB) and buses able to use either electric propulsion or self-generated power are referred to as Dual Mode Buses (DMB). All buses are assumed to be traditional over-the-road coach designs suitable for long distance travel. Smaller buses and vans could also be utilized to supplement proposed services, especially as part of the feeder and distribution systems that will be required to serve any fixed station locations that may be constructed in the corridor. Various implementation versions of this application are discussed below.

Bus in Mixed Traffic

Operation in mixed traffic means that buses are commingled with regular traffic on I-70. Under this option, buses operate in the same general purpose travel lanes as trucks and automobiles throughout the I-70 Mountain Corridor. Buses would operate from pick-up/drop-off points in Denver or from park and ride lots near the I-70 corridor. Capacity of this option is essentially tied to the capacity of the general-purpose I-70 travel lanes. Buses would have no special operating advantages and general traffic conditions along with mountain grades would limit speeds.

Bus in HOV

Operation in High Occupancy Vehicle (HOV) lanes refers to buses operating in special traffic lanes that are intended for buses, car pools, and any vehicle carrying a minimum number of passengers set by the HOV operator (usually 2 or 3). HOV lanes may be either a regular highway lane distinguished with specially painted lines, symbols, and signage; or a segregated roadway separated by barriers and utilizing special access ramps; or some combination of both marked and segregated roadways. A single HOV lane may be managed in such a way as to provide travel in the peak direction only, with buses returning in mixed traffic. Multiple HOV lanes may be constructed in order to provide expedited travel simultaneously in both directions. Buses in segregated HOV lanes can be expected to operate at or near posted speed limits, restricted only by grades, HOV traffic congestion, and/or unusual circumstances. Buses in marked HOV lanes are more prone to traffic disruptions as drivers caught in stalled traffic in the regular lanes will often illegally enter marked HOV lines by crossing over the painted lines. This severely limits the speed at which the bus operator can safely pass stalled traffic in the adjacent travel lanes.

Options for implementation under this general category are:

- Bus in marked HOV lane peak direction only
- Bus in marked HOV lane both directions
- Bus in segregated HOV lane peak direction only
- Bus in segregated HOV lane both directions

Bus in Separated Transitway

A transitway is a completely separate roadway limited to transit vehicles only. A transitway could be constructed either in the median of I-70 or as a separate parallel roadway. As with the HOV alternatives, a single lane transitway could be constructed and managed in such a way as to provide travel in the peak direction only, with buses returning in mixed traffic. Multiple lane facilities could also be constructed in order to accommodate travel in both directions at the same time. Buses can be expected to operate at or above the posted limits for I-70 (since transitways are only utilized by

professional drivers, speed limits can be set higher than for general traffic lanes). Mountain grades will still limit traditional bus performance, but travel speeds for DMBs or ETBs operating in a transitway would not be impacted by the grades due to their ability to draw whatever power is needed from their electric feeders. A relatively new variant of the "bus in transitway" approach to ground transportation is Bus Rapid Transit (BRT). This concept, in which buses only operate between fixed stations in the transitway (similar to a rail system), is gaining popularity and will be examined as well. Options for implementation under this general category are:

- Bus in transitway peak direction only
- DMB in transitway peak direction only
- Bus in transitway both directions (includes BRT examination)
- DMB in transitway both directions (includes BRT examination)
- ETB in transitway both directions (includes BRT examination)

Bus in Guideway

In this option, a separate roadway limited only to transit vehicles with special guideway attachments would be constructed in the median of I-70 or as a separate parallel roadway. These special guideway attachments reduce lane width requirements and allow for a higher speed operation. These buses operate normally outside the guideway. As with the HOV and general transitway alternatives, a single lane guideway could be managed in such a way as to provide travel in the peak direction only, with buses returning in mixed traffic. Multiple lane facilities could also be constructed in order to accommodate travel in both directions. Buses can be expected to operate at or above the posted limits for I-70 (since guideways are only utilized by professional drivers and have built-in steering control, speed limits can be set significantly higher than for general traffic lanes). Mountain grades will still limit traditional bus performance, but travel speeds for DMBs or ETBs operating in a guideway would not be impacted by the grades due to their ability to draw whatever power is needed from their electric feeders. Guideways have the additional advantage that electric buses can be powered from an unobtrusive 3rd rail arrangement rather than the traditional overhead wire design. BRT variations will also be examined for guideways. Options for implementation under this general category are:

- Bus in guideway peak direction only
- DMB in guideway peak direction only
- Bus in guideway both directions (includes BRT examination)
- DMB in guideway both directions (includes BRT examination)
- ETB in guideway both directions (includes BRT examination)

Fixed Guideway Transit

Like rubber tire transit alternatives, fixed guideway transit (FGT) alternatives consist of a variety of separate configurations of infrastructure and vehicle type. These systems can be exclusively divided into four distinct categories. Within those categories are a number

of implementation options for various track configurations, propulsion types, and operating characteristics. Due to the nature of fixed guideway operations, a collector/distributor system will be needed to shuttle between FGT stations and key origins/destinations along an I-70 corridor line. It is anticipated that this system would take the form of a rubber tired bus feeder network in both the Denver area and in numerous mountain destinations. Various implementation versions of this application are discussed below.

Automated Guideway Transit

These systems have the common characteristic that they provide service without a human operator. Their guideway therefore must be completely protected to ensure that the automated vehicles cannot contact people, automobiles, or other obstacles in the guideway. For this reason they generally operate only short distances and are considered urban systems. The Federal Railroad Administration (FRA) does not regulate them. They can be operated using conventional rail transit steel wheel vehicles, over rubber tires with a guide mechanism, or on a monorail.

Automated Guideway Transit systems in airports are often referred to as APM (Airport People Mover) systems. Automated Guideway Transit systems used for downtown circulation are often referred to as DPM (Downtown People Mover) systems. DPM systems are currently operating in Detroit, Miami, and Jacksonville. Automated Guideway Transit used in universities (Morgantown), hospital campuses (Duke), casinos (Las Vegas & Reno), amusement parks, and other institutions are usually referred to as either a people mover or by the technology used (i.e.: the monorail, the tram, the shuttle). Automated Guideway Transit technology has also been used for general urban circulation, operating like a subway or metro system. Only one example of this technology exists in North America as an automated system operating outside a downtown area and that is in Vancouver, BC.

Some Automated Guideway Transit systems have the ability to operate on multiple routes on either a preprogrammed schedule or on a demand basis determined by the rider. These systems are referred to as Personal Rapid Transit (PRT) or Group Rapid Transit (GRT). Only one true PRT system is in operation at this time. It is an experimental system built in 1974 in Morgantown, WV. It provides service to a large university campus. Riders select their destination like floors on an elevator. Each small car carries the rider and accompanying parties directly to the station desired, bypassing any other stations along the way. A complex GRT system was also built about the same time at DFW airport. It has numerous car destination groupings, but no rider control.

Automated Guideway Transit can be cable hauled, powered by electric traction, or utilize linear induction motors. The complexity of Automated Guideway Transit increases substantially when more than one vehicle can operate on the same guideway. Simple cable hauled systems handling only one vehicle per guideway are operated using common elevator technology. When more than one vehicle is on the guideway, a sophisticated signal system is necessary to provide safe separation between the vehicles and to control braking and acceleration. Since cable hauled systems cannot be used for long distances or with multiple vehicles on the same guideway, the propulsion choice for the I-70 Mountain Corridor is limited to electric traction and linear induction motors. The choice of guideways can be conventional rail, concrete deck, or monorail. Only certain combinations of the above are available. Either double guideways or single guideways with passing zones can be utilized.

Options for implementation under this general category are:

- AGT using conventional rail with electric traction on single track or double track
- AGT using conventional rail with linear induction motor on single track or double track
- AGT using concrete guideway with electric traction on single guideway or double guideway
- AGT using monorail with electric traction on single beam or double beam

Rail Transit

Options to utilize rail transit in the I-70 Mountain corridor consist of either light rail or heavy rail transit systems. Each type of system can be constructed as a double-track line or as a single-track line with passing sidings. Either electric or diesel propulsion systems are available. The tracks can be located in the median of I-70 or on a parallel alignment, diverging only for heavy grades or to serve off line stations. In this report the term "Rail Transit" is defined to mean any conventional rail vehicle designed to operate on tracks not connected to the national railroad network. These systems, when operated in an "urban" area, are exempt from Federal Railroad Administration (FRA) regulation.

Light Rail Transit (LRT) and Heavy Rail Transit (HRT) systems are typically operated with either overhead wire or third rail electric propulsion. Diesel propulsion is also available for either mode, which is referred to as a Diesel Multiple Unit (DMU) operation. LRT vehicles, unlike HRT vehicles, can if necessary operate on tracks in city streets along with motor vehicle traffic.

High capacity HRT systems must operate only on exclusive rights-of-way due to their large vehicle size, long train lengths, their inability to brake and accelerate within motor vehicle tolerances, and (often) the presence of a ground mounted electric third (power) rail. They do have many more options for power pick-up and automation than LRT systems but represent one of the highest costs per mile to construct. They are typically built solely with high level boarding platforms and the vehicles are usually custom built for each system. AGT systems that use operators, such as the Scarborough Line in Toronto, are really HRT systems and will be examined under this category

LRT vehicles meet all highway operating standards for braking, acceleration, directional turn signals, and sight distances from the operators position. Usually, though, these systems are operated on either a reserved roadway median or an exclusive right-of-way.

LRT systems have been expanding rapidly around the country due to their flexibility, relative low cost, and their widely available equipment and technology. LRT vehicles can utilize either low level or high level boarding platforms. Newer low-floor versions are also available to speed street level boarding. Vehicles are available from many suppliers and are often built to standard specifications.

Conventional rail transit systems are limited to a maximum gradient of about 6%. Rack systems have been used to supplement grade-climbing capability in many European systems and could be used to overcome some of the highest grades on the I-70 Mountain Corridor.

Options available for implementation under this general category are:

- Diesel LRT on single or double track
- Electric LRT on single or double track
- Diesel HRT on single or double track
- Electric HRT on single or double track

Passenger Railroads

Options to utilize Passenger Railroads in the I-70 Mountain corridor consist of six separate configurations of infrastructure and rolling stock. In this report the term "Passenger Railroads" is defined to mean any conventional rail vehicle operating on track connected to the national railroad network. These systems are regulated by the Federal Railroad Administration (FRA).

Passenger Railroads take on many forms but utilize common vehicles and operating practices, which allows for an evaluation among only those items that truly differentiate the group. Passenger railroads used in service between suburban areas and major cities are identified as Commuter Rail (CR) systems. Passenger Railroads used for intercity service utilize the same basic locomotives and cars (with slightly modified interiors). High speed rail systems are a variant of intercity service that uses higher performance equipment but still with the same basic characteristics as other passenger operations (with the exception of tilt-body trains which can round corners at higher speeds than would otherwise be acceptable for conventional services).

Passenger rail trains may be hauled by diesel locomotives or electric locomotives. The trains may also be made up of multiple unit cars, each with their own diesel or electric traction motors. When utilizing diesel propulsion these trains are often referred to as Diesel Multiple Unit (DMU) or their former name of Rail Diesel Car (RDC). Note the DMU term is also used for similar rail transit equipment, which frequently causes confusion. When utilizing electric propulsion these trains are often referred to as Electric Multiple Unit (EMU). Electric power for passenger rail transic can be delivered through overhead catenary wires or a third (power) rail.

Conventional railroad trains are limited to a maximum gradient of about 6%, although they are typically expected to operate with a maximum of 2% grade on most mainlines (although there are many exceptions). Rack systems have been used to supplement grade-climbing capability in Europe, but none have been tested nor approved for use in the United States for general passenger railroad use.

Passenger rail trains and multiple unit train cars can utilize either low level or high level boarding platforms. Stations are required for boarding and alighting. These systems are very flexible, as they are able to operate on both new alignments as well as large amount of existing trackage that can shared with freight trains. Locomotives and passenger rail cars are available from many suppliers.

Options available for implementation under this general category are:

- Diesel locomotive-hauled trains on single or double track
- Electric locomotive-hauled trains on single or double track
- DMU trains on single or double track
- EMU trains on single or double track

Advanced Guideway Systems

Unlike the time tested and easily available systems listed above, the Advanced Guideway Systems group represents those systems undergoing research and development and may not currently be available for testing and evaluation. In recent years, most ground transportation research has been focusing on two types of magnetic levitation (maglev) systems that can be used for a new generation of high-speed ground service. In addition, an older mode primarily used for transit applications, the monorail, has been proposed in various forms for higher speed intercity service.

The monorail concept utilizes a single elevated beam to carry a train over any groundbased obstructions. Vehicles can ride above the beam, hang from the beam, or run astride of the beam. The concept has been in operation since the 1950s in amusement parks, downtown circulators, and airport AGT systems. In Japan, some monorail systems are used between downtown areas and airports.

Monorails are operated essentially as Heavy Rail Transit since they are grade separated and cannot run in mixed traffic. They have many of the attributes and limitations of Heavy Rail Transit. Propulsion systems available for monorail trains use either conventional electric traction motors or a newly proposed linear induction motor system. Vehicles can be operated on the monorail using either rubber tires or steel wheels.

Maglev systems have been under development since the 1960s. Two types are being actively tested: (1) a German attraction based design where the magnets on the underside of the track are attracted to electromagnets on the car, which are used to levitate the car for high speed running and (2) a Japanese repulsion based design where the magnets on

the trough-type guideway push the car away from the sides and bottom to levitate it for high speed running.

Options available for implementation under this general category are:

- Monorail using electric traction
- Monorail using linear induction
- Maglev using attraction based levitation
- Maglev using repulsion based levitation

Level 1 Screening Process and Criteria

The issues to be addressed in the first level screening are Safety, Capacity, and Mobility.

- Safety addresses the conformance of the proposed technology to industry safety standards, the probability of vehicle accidents, the passenger injury rate per mile traveled, and the impacts on bystanders or other users in the corridor. For the first level screening, this criteria has been defined as the ability of the transit option to respond to and adequately handle issues of passenger safety and security, including being able to identify and avoid potential problems. This is measured by whether or not there is an operator physically operating the vehicle in this remote corridor to deal with incidents or issues as they arise.
- Capacity addresses the impacts to the extent and duration of existing and future traffic congestion on the I-70 Mountain Corridor. For the first level screening the transit option must have sufficient capacity to have a meaningful impact on congestion, either in number of vehicles removed from the roadway or by measurably shortening the length of congested periods. This is measured by the theoretical maximum capacity of each transit option.
- Mobility addresses the potential and actual movement of people and goods within the corridor. This can be evaluated by considering the total volumes of people and tons of freight moving through the corridor, the length of time necessary to traverse the corridor, the level of service to and access of local corridor communities, and the availability of appropriate and adequate transportation options within the corridor. For purposes of the first level screening, this has been defined and the ability of a transit option to maintain an average vehicle operating speed and achieve a total travel time (which includes loading and dwell times) reasonably comparable with the automobile. In addition, a judgment as to the likely level of access to corridor communities that can be achieved by each option is included.

In summary, the first level screening process is focused on identifying those transit options that can operate safely in the corridor, have a meaningful impact on congestion, and provide improved mobility for people and goods traveling in the corridor. Appendix A identifies the operational characteristics relevant to the above-described criteria for the 31 options identified earlier. The specific criteria that have been considered are:

- Maximum theoretical capacity in passengers per hour
- ✓ Percent of I-70 Mountain Corridor communities that could reasonably be served
- ✓ Average vehicle speed for the technology
- ✓ Corridor travel time including boarding and dwell times for ten intermediate stations
- ✓ Meets industry safety standards and utilizes an on-board vehicle operator

The maximum theoretical capacity of a transit option is determined by multiplying the average speed of the vehicle by the maximum capacity of vehicle and by the number of vehicles that can be operated within the travelway within a set time frame. The average speed is calculated by determining the maximum possible speed over any one travelway segment and then adjusting for grade limitations of the vehicle's powerplant, congestion from other vehicles, clear time for signal systems, station dwell, and off-line station access time. The segments are aggregated and the result is used for general comparison against other options. It should be noted that this method significantly overstates real-world capacity, but is valid for comparison among options. It should not be used to predict actual line capacity, as that modeling is a complex and time-consuming task that is not appropriate at the screening level of analysis.

Level 1 Screening Recommendations and Results

The I-70 Mountain Corridor presents a number of challenges to designers of transit alternatives. The grades limit vehicle performance. The curves limit speed. The right-of-way size limits the land available for infrastructure. The mountains limit the choice of power systems. The remoteness limits automation solutions.

In order to determine appropriate options for a more detailed evaluation of possible applications for the I-70 Mountain Corridor, it is necessary to screen the various options identified above in order to determine which have the greatest potential to address issues of concern in the corridor.

Many bus transit options include the possibility of operating along a special lane or guideway in the direction of peak traffic and having vehicles returning or operating in the non-peak direction use the regular travel lanes. The alternative is to build separate facilities for each direction of travel. Analysis of I-70 travel demand shows that during peak periods, 80% of the traffic is traveling in one direction, but only 20% in the opposite direction. This strongly supports consideration of building reversible flow transit facilities instead of dual-flow facilities. Accordingly, only peak direction facility options were recommended to be retained for further screening by the project team. However, at the request of the advisory committees, all RTT options will advance into the second level screening.

The issue of operation over a single track (or guideway) with passing sidings or a double track (guideway) structure is universal among the fixed guideway transit options. Single or double operation affects average vehicle speed and system capacity. The frequency and length of passing facilities significantly impacts the operational characteristics of the system. Since all of these systems have the same general impact from single or double operation, all systems will initially be compared using single track (guideway) scenarios with passing facilities assumed to be located at reasonable intervals consistent with the peak travel nature of this corridor. During later option refinement, the issue of single or double operating plans will be further evaluated.

The number of corridor communities served by a proposed system is a function of the proposed technology limitations on curve speed, acceleration/deceleration capabilities, and reasonable alignment assumptions. All of the transit options listed herein are able to operate over some portions of the existing I-70 Mountain Corridor alignment. Extreme grade limitations in some areas would force some options onto alternate alignments. Other systems, because of very high speed operation, are unable to follow the existing I-70 alignment due to the number and degree of curvature. These systems would most likely have to bypass some I-70 Mountain Corridor communities to operate at their designed speed. The number of communities that would have to be bypassed were expressed as a percentage of the total number of communities along the corridor and shown on Appendix B. High speed MagLev is one such system that would be unable to serve many of the communities along the corridor. The project team had initially recommended that this system be screened from further consideration. At the request of the advisory committees, a low speed version of the technology will be retained for further analysis.

Safety is paramount in all transportation operations. All of the transit options considered for the I-70 Mountain Corridor meet their industry requirements for safe operation. There are small differences in the passenger accident rate and the accident rate for rightof-way trespassers and for vehicles at grade crossings between these transit options, but not enough to warrant screening out any of these viable modes. One transit option, Automated Guideway Transit (AGT), by its very nature is designed to operate without an operator physically at the controls. These systems are intended for operation in restricted environments where emergency assistance is available on short notice. Typically this protection is provided in urban areas by fire, police, and medical personnel that can be quickly assembled at a service disruption and provide passenger evacuation and assistance. The remoteness and physical difficulty of accessing an AGT right-of-way in many parts of the I-70 Mountain Corridor makes this option unsuited to passenger safety needs. Due to this basic incompatibility, AGT systems are not recommended for further consideration, although the technology used for the longer distance versions of these systems will be evaluated as part of the Heavy Rail Transit and Monorail technologies. AGT with an operator (which is arguably an HRT system) is currently in operation in suburban Toronto.

ALTERNATE ROUTES

In order to determine if a particular alternate route will provide sufficient benefits to I-70 to warrant further analysis, the two basic criteria were applied at the first level of technical evaluation. These criteria, by the very nature of the first level screening process, are qualitative in nature with sufficient quantitative support to justify the basic conclusions. Subsequent levels of screening will incorporate increasingly more detailed quantification. The intent of the first level screening, therefore, is to eliminate alternatives which clearly do not meet the purpose and need of the I-70 PEIS.

Description of Alternate Routes

Many of the alternate routes may provide significant benefits to Colorado residents and the motoring public, not in terms of improvements to I-70, but rather in terms of other corridors or travel sheds. As a result it might be appropriate that they be considered further, perhaps for inclusion in the State-wide Transportation System Plan for example. However, if the potential benefits of an alternate route do not adequately address the problems along I-70, it is not a viable solution for the corridor.

Sixteen alternate routes have been defined which connect the central Rocky Mountains with the four principal cities along the front range. Three alternate routes connect to Fort Collins, seven with Denver and DIA, four with Colorado Springs, and two with Pueblo. All of these corridors are, in varying degrees, important elements of the Colorado state-wide transportation network. In fact, many of these corridors are planned to be upgraded while other corridors are increasing in statewide significance.

However, if the alternate route does not address the criteria of the "significant volume" and "motorist benefit" as used in the first level screening criteria, it is not responsive to the purpose and need of the I-70 PEIS and should not be considered as a feasible solution to the problems in the I-70 corridor.

Level 1 Screening Process and Criteria

The criteria used for the first level screening of the alternate routes are:

- First, the alternate route must have some reasonable potential to divert a significant volume of traffic off of the I-70 corridor.
- Second, the alternate route must provide a discernable benefit to the motorist to encourage them to divert from I-70. Such a benefit may be a shorter travel distance but, more typically, involves a reduced travel time, especially during peak demand periods.

The focus of those two criteria, when taken together, is to insure that the purpose and function of the alternate route is oriented toward resolving traffic problems on I-70. This is necessary to meet the objectives of the "Purpose and Need" statement for the I-70 PEIS.

Along the 170-mile extent of the front range between Fort Collins and Pueblo, it is estimated that the greater Denver metropolitan area (including DIA) is associated with approximately 90% of the traffic on I-70. This means that those alternate routes primarily associated with Fort Collins, Colorado Springs, and Pueblo will not attract sufficient traffic off of I-70 to meet the purpose of the I-70 PEIS or the needs of the I-70 corridor.

Level 1 Screening Recommendations and Conclusions

The seven alternative routes between the Denver metropolitan area and the central Rocky Mountains all involve longer travel distances than does a comparable trip along I-70. In addition, travel times via all seven alternate routes are greater than via I-70 during off peak travel periods.

However, during peak travel periods, two alternate routes may be able to provide competitive travel times with the I-70 corridor. These alternate routes are:

- A modified version of Alternate Route 5 which utilizes SH 58, SH 93, and SH 72 (to Rollinsville) in conjunction with a new tunnel (paralleling the Moffat Tunnel) eventually connecting to Winter Park.
- Alternate Route 8b which utilizes US 285 to Jefferson in conjunction with a new tunnel under Georgia Pass connecting to SH 9 north of Breckenridge and continuing onto Frisco and I-70.

Further, analyses are required to determine the feasibility of these two alternate routes. Such a feasibility analysis will include a more detailed analysis of travel times and traffic diversion along with consideration of costs and potential impacts.

Therefore the results of the first level screening of alternate routes are:

- Alternate Routes 1, 2, 3, 10a, 10b, 11, 12, 13a and 13b are not carried into the second level evaluation because they have virtually no potential to divert any significant traffic volume off of the I-70 corridor. Without such traffic diversion, the purpose and need of the I-70 PEIS is not served.
- Alternate Routes 4, 6, 7, 8a, and 9 are not carried into the second level evaluation because they do not provide any travel benefit to the motorist in terms of reduced travel distance or reduced travel time. Without such travel benefits, no trip diversion from I-70 will occur and the purpose and need of the I-70 PEIS is not served.

• More analysis is required to better understand the feasibility of a modified Alternate Route 5 and Alternate Route 8b.

Alternate Route 5 (modified) and 8b will be carried into the second level screening.

AVIATION

Potentially reasonable air transportation alternatives were culled from various sources including the Federal Aviation Administration's (FAA) Airport Capacity Branch, FAA's 1999 Airport Capacity Enhancement Plan, FAA enplanement data, aviation directors and airport managers of the mountain corridor airports, and AirNav data. Four promising alternatives were identified from the I-70 Mountain Corridor Major Investment Study Alternatives Analysis Report and carried forward. Two were added for consideration in this phase.

Description of Aviation Alternatives

The following alternatives are predominantly capital improvement oriented and it is important to consider the realm in which the more capital-intensive alternatives could occur. For example, many airports in Colorado are under the direction of local airport authorities, county commissioners and city elected officials. Compared with some other states, historically, the planning and implementation of Colorado's transportation systems have been heavily weighted toward its highway system rather than its air transportation system. The Colorado Department of Transportation (CDOT), who enjoys a good working relationship with the Federal Aviation Administration (FAA), conducts planning for alternative modes and aeronautics. However, its aviation role and determining the siting of new airports or improvements to existing airports, primarily has been one of a coordinating agency, as opposed to a lead agency.

It also is important to note, particularly with regard to the final alternative, which is more market-based, that the cost and implementation of travel demand management strategies such as "seat guarantees" and flight scheduling fall within the realm of private sector entities such as the airlines and resort operators. A strong partnership with the local community's chambers of commerce and public sector entities are critical, nonetheless. The policy needed to implement these strategies must evolve from a process that will result in buy-in and willingness on the part of the stakeholders to financially support the strategies.

The six alternatives are described below. Intentionally, the descriptions are designed to frame the issues and avoid conclusions about the viability of the alternatives until input can be sought from the citizen-based Mountain Corridor Advisory Committee and the staff-based Technical Advisory Committee.

Alternative 1: Develop new airports in the mountain corridor

This alternative provides the siting and construction of entirely new airports at appropriate locations in the corridor, with all new terminal, airfield and landside facilities. The airports would be designed to accommodate commercial service and allow

access to the national air system and potential all-weather capability very similar to Aspen-Pitkin County/Sardy Field (ASE), Eagle County Regional Airport (EGE), Walker Field (GJT) and Yampa Valley Regional Airport (HDN).

With regard to the capacity criterion, obviously the new airport(s) would be designed given sufficient and appropriate land in the corridor where the terrain is relatively flat and reasonably unconstrained. It is also presumed that mobility/accessibility would be addressed as the airport would be sited in proximity to major activity centers. Airport safety could be presumed to be better as larger airports with greater runway capacity and air traffic control ability are safer compared to smaller airports. Extremes of weather and terrain are unchanged, but larger aviation facilities and enhanced technologies can accommodate larger aircraft that are better equipped to handle these challenges.

Nevertheless, aviation experts have indicated that commercial service capacity is not an issue in the mountain corridor. In fact, there is a shortage of general aviation facilities. This issue is expanded upon in the description of similar alternatives below.

Alternative 2: Develop heliport and short take-off landing (STOL) facilities

This alternative provides new or revamped aviation facilities that could accommodate vertical flight aircraft such as rotocrafts, tiltrotors and tilt-wing aircraft. These facilities could be constructed at existing commercial service and general aviation airports but would require exclusive heliport pads independent of the runways. Special hangars and tie-downs also would be necessary for storage of these types of aircraft.

It is likely that greater capacity and the ability to meet travel demand would not be realized, as vertical flight aircraft tend to be small and hold fewer passengers. Additionally, vertical flight aircraft operate at half the speed of conventional aircraft and are noisier during take-off and landing. Likewise, the impact on mobility, again intuitively, would be less as these types of aircraft hold fewer passengers, thus diverting an insignificant number of cars from the highway.

With regard to safety, vertical flight aircraft, as compared to conventional large aircraft, are less equipped to deal with the extremes of mountain weather conditions such as ice, snow and wind.

Alternative 3: Improve existing commercial service aviation facilities

This alternative includes a variety of improvements to the Aspen-Pitkin County/Sardy Field (ASE), Eagle County Regional Airport (EGE), and Yampa Valley Regional Airport (HDN) airports that would allow them to accommodate greater commercial airline service. These improvements include longer runways and the addition of crosswind runways that would allow more planes to land under acceptable wind conditions.

Greater capacity could indeed accommodate travel demand and be expected to alleviate corridor highway congestion. Mobility could be expected to be enhanced, and accessibility and proximity to activity centers has been proven. Safety could be expected to be improved as the existing commercial service airports are designed to accommodate large conventional aircraft of the type suitable for regional airports (e.g., BAE 146 and

737s) and thus are better equipped to deal with the challenges of mountain weather and terrain.

However, as mentioned previously, capacity at commercial service airports is sufficient, if not abundant.

Additionally, advances in aircraft technology and performance offer greater capacity as more aircraft can be accommodated during more types of weather. For example, higher output engines with greater climb capabilities allow aircraft to operate at higher altitudes where previously long runways were needed to obtain the lift necessary for flight.

The Federal Aviation Administration (FAA) has undertaken a long-term effort known as the National Airspace System Modernization to accommodate air traffic growth and to meet the increased safety and efficiency demands placed on the air traffic control system. These proposed improvements include:

- Increased ability of users to fly more direct routes
- Expanded surveillance coverage
- Clearer, less congested, air/ground communications
- Optimized flight profiles
- More efficient sequencing of air traffic
- Accurate and timely weather and traffic information in the cockpit

"Free flight" is the impetus for these changes. Free flight offers pilots greater flexibility and discretion in determining routes and speeds. As the move toward free flight continues, NAS users will face fewer restrictions in their flight operations, resulting in more choices, fewer delays, and lower operating costs.

Capacity – at both commercial service and general aviation airports (because GA will benefit greatly from NAS Modernization) -- may very well be "grown" through technological advances and therefore diminish the need for infrastructure improvements or new facilities. And, absorbing that "growing" capacity may have more to do with market-based strategies such as those outlined in Alternative Six below.

Alternative 4: Improve existing general aviation facilities to accommodate commercial operations

This alternative includes improvements to Lake County Airport in Leadville (LXV), Glenwood Springs Municipal Airport (GWS), or Kremmling Airport (formerly McElroy Field) (20V). Similar to improvements to existing commercial service airports, improvements to general aviation facilities include lengthening runways, strengthening runway pavement, adding cross-wind runways, adding IFR (instrument flight rules) or precision instrument landing capabilities, and staffing air traffic control towers.

Similar to improving commercial service airports, the increased capacity could be expected to accommodate travel demand in the corridor and mobility could improve as more cars are diverted from the highway to air transportation. Airports with better

runway facilities and enhanced technologies can accommodate larger aircraft and thus better deal with the vagaries and hazards of mountain weather.

Nevertheless, capacity of commercial service airports is not the issue. Instead, commercial service airport capacity is underutilized eight months out of the year as most facilities are designed for the peak winter season. Second, there is a shortage of general aviation facilities, those facilities typically used by air taxi services (with four to six passengers), recreational flyers and private charters. At least one of the commercial service airports in the mountain corridor is considering development of its GA facilities, not to compete with nearby GA facilities, but to accommodate the growing demand for GA facilities.

The Federal Aviation Administration (FAA) has developed a strategic plan called the General Aviation Roadmap to stimulate the production of safe, affordable and fast GA aircraft over the next 25 years. This would greatly enable "doorstep-to destination" travel (at four times the speed of highway travel) to 25 percent of the nation's suburban, rural and remote communities in 10 years. Improvements such as those mentioned above are necessary to accommodate this growth; real-time graphical weather and traffic information and precision instrument (IFR) approaches, in particular.

Alternative 5: Develop Walker Field into a western slope regional hub airport

This alternative includes expansion of the Walker Field airport to provide access to the national air transportation system, similar to Colorado's two existing hub airports, Denver International Airport (DIA) and Colorado Springs (COS).

Similarly, Walker Field's runways would be lengthened to twice their existing lengths and larger hangar facilities and terminal amenities would be added to accommodate greatly increased air passenger activity. Capacity would be enhanced and the larger airport could offer a poor-weather alternative to the smaller regional airports (ASE, EGE and HDN). Traffic congestion between Glenwood Springs and Grand Junction is also greatly diminished in this section of I-70 and much of the traffic previously travelling from DIA, ASE, EGE or HDN would be coming east-bound through currently less congested stretches of the highway.

However, Walker Field once was a gateway or hub airport, and its function in that respect has changed greatly. Until the development of ASE, EGE and HDN as regional commercial service airports, Walker Field served as a gateway airport to these resort communities and a gateway airport alternative to DIA. It is likely that Walker Field will not resume its position as a hub or gateway airport in light of the capacities of ASE, EGE and HDN, as well as technological advances that make it increasingly safer to use the smaller, regional commercial service airports.

Additionally, shifting the transport of goods from truck to aircraft historically has been deemed to have too insignificant an impact on highway congestion given the small increase in capacity relative to the enormous cost (e.g., one plane carries about as much cargo as one truck). Nevertheless, state aviation officials have cited Walker Field as ideal for increased cargo distribution to alleviate cargo operations at HDN, EGE and ASE.

Alternative 6: Develop aviation systems management and subsidy programs

Includes scheduling techniques combining two or more destination markets on the same flight and the use of seat guarantees or subsidies to encourage air travel.

This alternative is very similar to what is known as travel demand management (TDM) where a variety of strategies are implemented to encourage or discourage singleoccupant-vehicle driving. An example would be the subsidization of vanpool seats by an employer or municipality to maintain a vanpool route. Empty seats are paid for or passenger fares are "bought down." In the case of aviation, similar market-based solutions, such as fare subsidies to air passengers (or "buying down" the cost of the ticket) or guaranteed revenue to airlines, are offered to encourage people to fly and to encourage airlines to continue otherwise unprofitable flights. In some cases, both incentives may be offered.

For years, "guaranteed seats" (also known as guaranteed revenue to the airlines) have been offered and the cost borne by the ski resorts to ensure airline service and routes into the mountain corridor airports. Only Eagle County Regional Airport (EGE) has been successful in weaning itself off of these types of incentives due in large part to less seasonal fluctuation and considerable growth in enplanements over the past ten years. EGE's location in the corridor directly off of I-70, compared with the remote locations of the other primary airports, contributes to its success as well.

The other mountain corridor airports continue to rely on subsidy programs and have begun strategizing ways in which they can involve summer-oriented activities (e.g., golf packages, conferences and conventions, rafting and bicycling trips) to bear the costs of summer time "guaranteed seats." This also would result in better year-round use of their airports. Consideration also has been given to involving the real estate community because of the burgeoning growth in second homes.

In addition to determining who should bear the cost of aviation subsidy programs, such programs also require constant analysis of the travel demand market. Each year, community leaders (comprising the resorts, chambers and local municipalities) engage in contract negotiations with the airlines to set the number of seat guarantees based on the previous year's lift ticket sales. Each dip in lift ticket sales (as Colorado has seen for two consecutive years now) weakens a community's bargaining power with the airlines.

Considerable discussion has taken place regarding the market's ability to bear the cost of air travel. Anecdotally, it has been learned that a family planning a ski vacation to the Colorado mountains already is incurring a large expense, and airfare is only one proportional piece of that expense which the family (or market) is willing to bear. Many experts tie this ability to bear the cost of a Colorado ski vacation to the nation's increasing economic wealth. However, similar to any market product or service, this "ability to bear the cost" will always be subject to price elasticity, which ski communities and the airlines grapple with each year as they negotiate "seat guarantees."

Increasingly, consideration also is given to trends relevant to the aging Baby Boomer population. For two consecutive years, lift ticket sales have declined in Colorado as skier

numbers decline and vacationers access the Internet for vacation ski packages around the world. Tourism authorities have urged greater marketing (the state's tourism tax to fund promotion ended in 1994 and the newly re-established office has a budget which is only a third of its previous years' campaigns), in particular, to younger outdoor enthusiasts, such as snowboarders.

Another market-based strategy is the combining of two destinations into one flight. For example, an airline could make stops at Aspen-Pitkin County/Sardy Field (ASE) and Yampa Valley Regional Airport (HDN) and serve two destination markets. Flights from U.S. cities to destinations in Mexico are often combined in such a fashion (e.g., Cancun and Cozumel on the Yucatan Peninsula).

The combining of two destinations is enabled by advances in aircraft fleet. Increasing use of regional jet aircraft, known as RJs (also dubbed mini-757s), has resulted in a shift from large propeller-driven aircraft, the type often used at mountain corridor airports. These RJs accommodate 50-80 passengers and allow airlines to offer nonstop flights from large, international airports with markets of 4-5 million. As airlines extend their route structures to cities previously beyond the range of propeller aircraft, they serve nonstop markets previously too small for direct service and reduce the travel time in markets they already serve. The changeover from propeller to regional jet aircraft is expected to continue and accelerate, as passenger acceptance of jet aircraft has proven higher than for propeller aircraft. RJs are projected to contribute to an 87 percent increase in regional/commuter enplanements by 2010.

NAS (National Airspace System) Modernization benefits market-based solutions as well. For example, the ability to combine two destinations on one flight is enhanced as NAS Modernization offers greater route flexibility and improved planning for fuel- and timeefficient flight plans. Moreover, as modernization contributes to more choices and lower operating costs for airlines, it can be expected to benefit the air transportation consumer with more choices and affordable fares.

Level One Screening Process and Criteria

The criteria, as they are applicable to evaluating the aviation alternatives, are further described below.

Capacity

To determine the potential of an alternative to offer additional capacity that would meet the demand for mountain corridor travel, one integral question was posed regarding the feasibility of airport expansion or creation. In other words, each alternative was screened (where applicable) relative to the question: Is there sufficient and appropriate land available for construction and expansion? Additionally, consideration was given to what type of improvements are needed.

<u>Mobility</u>

Alternatives also were measured relative to their contribution to enhanced mobility and accessibility in the corridor. At this first screening level (as previously mentioned),

mobility was intuitively evaluated as compared with its more typical application in transportation planning where a mode is evaluated for its quantitative impact on traffic congestion (e.g., the number of people in cars removed from the road). More importantly, while it is intuitive that greater air passenger travel would remove cars from the highway, accessibility to and from mountain corridor airports is critical to the viability of an airport. Therefore, with regard to an alternative's impact on corridor mobility, in the case of construction of new airports or expansion of existing airports, the question also was posed regarding reasonable proximity and accessibility to major activity centers in the corridor.

Safety

Finally, the alternatives were evaluated relative to safety for air passengers as mountain corridor airports accommodate greater air service activity. Similar to mobility, safety – which is typically applied to an alternative's ability to alleviate congestion and reduce highway accidents – was considered relative to the safety of the new or expanded aviation facility. In this case, safety was defined as airport safety by posing the question: Is the existing airport location (or general region intended for a new airport) free of major topographical and meteorological conditions that would hamper air activity expansion?

It is important to note that in the first level of screening, the criteria are used in the strictest sense without any regard for political acceptability or community values that will be applied later in the environmental assessment stage. For purposes of this first level screening process, the alternatives are evaluated in light of technological feasibility or logistical application. Moreover, the first level screening process is intended to *frame the issues*. This "framing of the issues" will shape the second level screening criteria and further fine-tune the process by which alternatives are carried forward.

Level One Screening Recommendations and Results

As mentioned previously, the alternatives are very capital-intensive with the exception of Alternative Six, which is market-based. Remarkably, given the current situation and absence of demand for greater airport capacity in the mountain corridor, alternative 6 appears to offer a feasible solution to encouraging, or maintaining air passenger travel. Clearly, technological advances will drive airport capacity and market-based strategies. Although alternatives 3 and 4 would offer additional capacity, enhance mobility within and accessibility to the corridor, and presumably improve safety, these alternatives are anticipated to be implemented regardless of the demand places on the I-70 Mountain Corridor.

APPENDIX A

I-70 Mountain Corridor Programmatic EIS First Level Screening Criteria - Transit Alternatives Characteristics

	ode	Capacity Psgr/Hr.	Percent Access to Corridor Communities	Average vehicle running speed (MPH)	Corridor Travei Time Including Boarding and Dwell Time (Hrs)	Passenger SAFETY Operator on board?	Description of General Service Characteristics and Special Requirement
X	ubber Tire Transit			~			"Bus" is defined to mean any self-powered vehicle designed for commercial use capable of operating on state roads gasoline, natural gas, propane, electricity or other alternate fu
	Bus in Mixed Traffic						Buses are commingled with regular traffic on I-70 in the same general purpose lanes as cars and trucks. Speed is grades.
	us in mixed traffic, both directions Bus in High Occupancy Vehicle ane (HOV)	2,459	100	38.5	5.09	Y	HOV lanes refer to buses operating in special traffic lanes intended for buses, carpools, and any other vehicles carry HOV traffic conditions and grades.
	us in HOV Marked Lane, peak irection	41,687	100	42.2	4.84	Y	
	us in HOV Marked Lane, both irections	42,439	100	45.7	4.59	Y	
	us in HOV Segregated Lanes, peak irection	46,637	100	47.5	4.17	Y	
	us in HOV Segregated Lanes, both irections	50,835	100	49.2	3.75	Y	A Transitway is a completely separate roadway limited to transit vehicles only. These can be single or multiple lan
Control of the	Bus in Separated Transitway us in Separate Transitway, peak						speed restricted only by grades or special circumstances. Bus Rapid Transit (BRT) is an approach that allows bus Light Rail Transit. Electric buses require overhead wires.
d	us in Guided Transitway, peak	55,361	100	44.7	4.01	Y	
	irection lybrid Electric Bus (HEB) in Separate	55,809	100	46.4	3.9	Y	
	ransitway, peak direction IEB in Guided Transitway, peak	76,636	100	64.8	3.12	Y	
d	irection	72,589	100	51.2	3.64	Y	
	us in Separate Transitway, both irections	57,144	100	52.3	3.59	Y	
COLUMN TWO IS NOT							This option is a separate roadway with guideway attachments to control the direction and alignment of the buses. The
	Bus in Guideway rus in Guided Transitway, both irections	58,108	100	57.5	3.38	Y	maintain vehicle operating speed. These could be single or multiple lanes. Electric bu
ŀ	IEB in Separate Transitway, both irections	77,802	100	69.8	2.98	Y	
H	IEB in Guided Transitway, both irections	78,841	100	74.7	2.86	Y	
	lectric Bus (EB) in Separate ransitway, both directions	77,802	100	69.8	2.98	Y	
	B in Guided Transitway, both irections	78,841	-100	74.7	2.86	Y	

Travel Time <u>Passenger</u> Percent Access [,] Average including <u>SAFETY</u>

FGT alternatives may be characterized by their means of support, guidance, propulsion, and/or control mechanisms. Due to the line-haul nature of these alternatives and the need for stations to board and deboard passengers, extensive RTT feeder and distribution services will be required at all station locations.



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ids carrying in excess of six passengers. Fuel may be diesel, a fuels.

is dependent on general traffic conditions and is limited by

rrying a minimum number of passengers. Speed is limited by

lane facilities. Buses would operated at or near the posted buses to essentially operate with the same characteristics as les.

These attachments reduce lane width requirements and help buses require overhead wires.

CORPORATION

nents

I-70 Mountain Corridor Programmatic EIS First Level Screening Criteria - Transit Alternatives Characteristics

These systems provide service without an operator; therefore the guideway must be completely protected. For this reason, these systems operated only within defined "urban areas" and only for short distances. The absence of an operator on board presents major safety and security concerns for passengers in a corridor of the length and remoteness of the I-70 environment.

	Automated Guideway Transit (AGT) using Conventional Rail with Electric Traction	16,035	90	74.7	1.91	N
	AGT using Conventional Rail with Linear Induction Motors	16,035	90	74.7	1.91	N
	AGT Concrete Guideway with Electric Traction	16,035	90	74.7	1.91	Ν
	AGT using Concrete Guideway with Linear Induction Motors	16,035	90	74.7	1.91	N
	AGT using Monorail with Electric Traction	16,035	90	74.7	1.91	N
	AGT using Monorail with Linear Induction Motors	16,035	90	74.7	1.91	N
	Rail Transit					
	Diesel Multiple Unit (DMU) on single					
	track with passing sidings	4,912	80	53.1	2.76	Y
	DMU on double track	6,163	80	63.8	2.37	Y
_	Light Rail Transit (LRT) on single track with passing sidings	12,681	100	58.3	2.39	Y
	LRT on double track	15,988	100	69.8	2.03	Y
	Heavy Rail Transit (HRT) on single					
	track with passing sidings	20,481	90	62.3	2.24	Y
	HRT on double track	25,937	90	74.7	1.91	Y
	Passenger Railroads Diesel Locomotive Hauled Train	13,525	80	53.1	3.13	Y
	on Single Track	13,020	ov	55.1	3.13	I

Automated Guideway Transit

on Single Track Υ Diesel Locomotive Hauled Train 17,078 80 63.8 2.74 on Double Track Electric Locomotive Hauled Train on Single Track 13,713 80 58.3 2.60 Y Electric Locomotive Hauled Train on Double Track 17,301 80 70.2 2.23 Y **Electric Multiple Units on Single** Track with Passing Sidings 80 Υ 16,938 62.6 2.45 EMU on Double Track 21,402 80 74.7 2.11 Υ

Advanced Guideway Systems					
Monorail Aerial Structures	29,955	80	100.0	1.69	Y
Magnetic Levitation Trains (Attraction Based)	40,284	20	178.9	1.12	Y
Magnetic Levitation Trains (Repulsion Based)	40,817	20	259.2	0.91	Y

Options for rail transit in the corridor consist of either light rail (LRT) or heavy rail (HRT) systems. LRT and HRT generally utilize electric propulsion, although diesel multiple units (DMU) can be a part of this group. LRT can, if necessary, operate on tracks in city streets with motor vehicle traffic. HRT differs from LRT by its requirement for an exclusive right-of-way.

Overhead wires are required for electric propulsion. Could use RTD LRT for distribution in Denver.

Heavy rail would be required to divert around Eisenhower Tunnel.

Passenger railroads are defined as any conventional rail vehicle operating on track connected to the national railroad network. These systems are regulated by the Federal Railroad Administration (FRA). Conventional railroads are limited to a maximum gradient of 6%, although they are usually designed to operate with only a maximum grade of 2%. AMTRAK, which operates in the corridor, is an example of this system. Could connect with existing track at Golden and Dotsero.

The most appropriate types of systems that are reasonably available for implementation in the corridor are monorail (existing and in service) and magnetic levitation (maglev) on which there are prototypes and extensive research. Maglev has severe curve limitations and would require extensive tunneling.

Rural nature of the corridor will make rescue and emergency response very difficult.

APPENDIX B

	Highway and			ments Family		
Alternatives	Safety			N# - 1- 11*4	Alternatives Retained for Level 2	
Adding Standard Lanes	Safety		Wil	Mobility Il the alternative reduce	Screening P	
"Smart" Widening			traf	fic congestion at	P	
"Flex" Lanes *			pro	blematic areas?	P	
Reversible Lane with Fixed Barrier				blematic areas are	P	
Moveable Barrier			defi	ined as:	P	
Idaho Springs Parallel Route	Will the alternative reduct safety problems:	the following		low Level of Service	P	
Curve Smoothing *	• •			OS E or F for 2000). OS F occurs when	P	
Climbing Lane *	• Roadway Geometry – Horizontal curves			niform traffic flow	Р	
Tunnel Capacity Improvement	– Vertical curves			nnot be maintained. ne flow conditions are	P	
New Tunnel from Downieville to	Accident Prone Areas		su	ch that the number of	Р	
Silverthorne	- High number of incid	lents		chicles that can pass a pint is less than the	· .	
Interchange Reconfiguration/Access Consolidation *	 Rock fall zones Ice build–up/snow pack areas Inclement weather areas 			umber of vehicles	Р	
Local Access Improvement *				riving at that point.	Р	
Structured Lanes (alternative concept)				here there is extensive	Р	
Covered Lanes (alternative concept)			tra	affic delay caused by	Р	
				adway geometry onstraints (i.e., steep		
Structured lanes specifically for trucks *				rades or lane drop areas).	Р	
* These alternatives are also considered Trans	portation Systems Manage	ement, which is sp	ecifie	ed under the Transportatio	n Management Family.	
		Routes Famil	У			
Alternatives	Screening Safety	g Criteria Mobility	-	Alternatives F	Retained for Level 2 Screening	
 Fort Collins to Wolcott via Walden (includer SH 14 and SH 131) Fort Collins to Wolcott via Kremmling (includes US 34) 	Ĩ	noonity		I-70 and travel distance i percentage (1.9%) of trav meaningfully reduce the	ow percentage (1.9%) of travelers	
3 - Fort Collins to Copper Mountain via Kremmling (includes US 34 and SH 9)				Screened out due to the low percentage (1.9%) of travelers originating from the area.		
 4 - Denver to Wolcott via Moffat Tunnel (includes SH 72, US 40, and US 34) 5 - Denver to Copper Mountain via Moffat, 		• Does the alternative rou	ite	Screened out since travel time is not competitive with congested I-70 and travel distance is 20 miles more than I-70.		
Berthoud and Jones Pass Tunnels (includes SH 72 and SH 9) 5a - Denver to Winter Park via Moffat Tunnel		distance than a trip via I-70?		Screened out since travel time is not competitive with conge I-70 and travel distance is 20 miles more than I-70.		
(includes SH 72)				P		
6 - Denver to Wolcott via Berthoud Pass Tunne (includes US 40 and US 34)	1			Screened out since travel time is not competitive with congest I-70 and travel distance is 20 miles more than I-70.		
7 - Denver to Copper Mountain Jones Pass		• Does the	. [Screened out since travel time is not competitive with con		
Tunnel (includes SH 9) 8a - Denver to Copper Mountain via Hoosier	Does the alternative	alternative rour provide a short			s 20 miles more than I-70. time is not competitive with congested	
Pass (surface) (includes US 285 and SH 9)	meet highway standards?	or equal to trav	vel	I-70 and travel distance i	s 20 miles more than I-70.	
8b - Denver to Copper Mountain via Georgia Pass Tunnel (includes US 285)	stulidurds.	time than a trip via I-70?	2		Р	
9 - Denver to Minturn via Buena Vista (include US 285 and US24)		• Does the	ta	Screened out since travel time is not competitive with c I-70 and travel distance is 20 miles more than I-70.		
10a - Colorado Springs to Copper Mountain via Hoosier Pass (surface) (includes US 24 an SH 9)			le	Screened out due to the low percentage (2.7%) of travoriginating from the area.		
10b - Colorado Springs to Copper Mountain via Hoosier Pass Tunnel (includes US 24 and SH 9)		reduce the traff flow on an extended segm		Screened out due to the low percentage (2.7%) of travelers originating from the area. Screened out due to the low percentage (2.7%) of travelers originating from the area.		
11 - Colorado Springs to Minturn via Buena Vista (includes US 24)		of I-70?				
 12 - Colorado Springs to Copper Mountain via Buena Vista (includes US 24 and SH 91) 13a - Pueblo to Copper Mountain via Hoosier 				Screened out due to the low percentage (2.7%) of travelers originating from the area. Travel time not competitive with congested I-70 and travel distance is 20 miles more than I-70. Screened out due to the low percentage (0.3%) of travelers		
Pass (surface) (includes US 50 and SH 9) 13b - Pueblo to Copper Mountain via Hoosier Pass Tunnel (includes US 50 and SH 9)				originating from the area	low percentage (0.3%) of travelers	
2 and 2 and in morados 0.5 50 and 511 7)		viation Famil				
Alternatives	Safety	Screening Crite	eria	Mobility	Alternatives Retained for Level 2 Screening	
Develop new airports in the mountain corridor	Salety			there sufficient and ppropriate land	Screened out since there are no sponsors or air travel demand, and it is	
Develop heliport and short take-off-and- landing (STOL) facilities				vailable for onstruction and xpansion? ow viable is the location	difficult to site. Screened out because the smaller aircraft that could use the facilities: carry too few passengers and are less equipped to deal with weather and mountain terrain.	
Improve existing commercial service aviation	Is the location relatively free of major		of	f the airport?	P	
facilities	topographical and meteor	rological	• Is the location in		Г 	
Improve existing general aviation facilities to accommodate commercial operations	conditions that would hamper air traffic activity expansion?		th	easonable proximity to be major activity centers f the corridor?	Р	
Develop Walker Field (the Grand Junction airport) into a West Slope regional hub airport			• W ha po	Yould this alternative ave a significant, ositive impact on I-70 Yehicle Miles Traveled	Screened out since Walker Field is already under utilized. It is no in the travel trend because Hayden, Rif and Glenwood Springs Airports are successful for general aviation purposer	
Develop aviation systems management and subsidy programs				VMT) and/or Vehicle lours Traveled (VHT)?	P	

	Transportation Managem		Altownoting Detailed 1.0
Alternatives	Screening Crite Safety	eria Mobility	Alternatives Retained for Level 2 Screening
Transportation System Management (TSM): • Highway improvements • Flex lanes • HOV lanes • Curve smoothing • Slow-moving vehicle lanes • Interchange improvements (longer acceleration and deceleration ramps) • Incident Management Program • Trucking Operations Plan • Improved maintenance • Access management • TSM for Transit • Skier express service • Private shuttle service • Local transit operations • Intermountain bus service • Amtrak Ski Train	Does the alternative meet safety standards as specified by FHWA/CDOT and the American Association of State Highway	Is the alternative compatible with CDOT's	P
 Travel Demand Management (TDM): Marketing of alternate modes Intermodal transfer centers Park-n-ride lots (places to meet and carpool) Parking management programs Time-of-use restrictions Congestion pricing Land use strategies 	and Transportation Officials (AASHTO)/ Manual of Uniform Traffic Control Devices (MUTCD)?	long term TSM/TDM/ITS plan?	Ρ
Intelligent Transportation Systems (ITS): • Traveler information • Traffic management • Vehicle control • Commercial vehicle systems • Public transport • Emergency management systems • Electronic transactions • Safety systems			Ρ
	Fixed Guideway Transit (F	· · · ·	
Alternatives	Screening Crite Safety	eria Mobility	Alternatives Retained for Level 2 Screening
Automated Guideway Transit (AGT) These systems (powered by either electric traction or linear induction motor) include: conventional rail, concrete guideway or monorail. Rail Transit Diesel Multiple Unit (DMU) on a single track with passing sidings or on a double track Light Rail Transit (LRT) Either on a single track with passing siding or on a double track Heavy Rail Transit (HRT) Either on a single track with passing sidings or on a double track Passenger Railroad • Diesel locomotive train on a single track with passing sidings or on a double track • Electric locomotive train on a single track with passing sidings or on a double track • Electric Notor Unit (EMU) on a single track with passing sidings or on a double track • Advanced Guideway Systems • Monorail • Magnetic Levitation (Maglev) attraction based or repulsion based	Does the alternative meet passenger safety and security standards?	 Does the alternative meet the following criteria: Meet the maximum theoretical capacity (passenger /hour). Provide sufficient access to mountain corridor communities. Average vehicle speed (mph), with and without stops, must be capable of transversing the 127- mile corridor from C- 470 to Dotsero in less than 3.5 hours. 	This group has been divided into 2 subgroups: long haul and short haul. Short haul systems were screened out because they are not suited for the Mountain Corridor environment. Long haul systems will be retained for Leve 2 Screening; however, they will be included under the HRT alternatives. P P P Monorail systems are retained for Leve 2; however, maglev systems were screened out due to curve/grade limitations. It would be difficult to serve all corridor communities.
	Rubber Tire Transit (RT Screening Crite		Alternatives Retained for
Alternatives	Safety	Mobility	Level 2 Screening
Bus in mixed traffic Bus in High Occupancy Vehicle (HOV) Lanes Either in a marked lane (peak direction only or both directions) or a separated lane (peak direction only or both directions) Bus in a separated transitway	Does the alternative meet passenger safety and security standards (measured	 Does the alternative meet the following criteria: Meet the maximum theoretical capacity (passenger /hour). Provide sufficient access to mountain corridor communities. Average vehicle 	P All options will be retained for Level 2 screening. The initial recommendation was to screen out the bus in separated HOV (both directions) because the excessive capacity is not needed in non peak directions.
All options include peak direction only or both directions by: traditional bus, hybrid electric bus (HEB) or electric buses Bus in guideway • Hybrid electric bus (HEB) (peak direction only or both directions) • Traditional or electric bus (both directions) Bus Rapid Transit (BRT)	by the presence of an operator)?	speed (mph), with and without stops, must be capable of transversing the 127- mile corridor from C- 470 to Dotsero in less	P

I-70 MOUNTAIN CORRIDOR

PROGRAMMATIC EIS

TRANSIT ALTERNATIVES

DRAFT FINAL REPORT

Prepared For:

J. F. Sato & Associates

Prepared By:



June 1, 2000



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INTRODUCTION

A number of transit alternatives to highway expansion are available to handle the growth in traffic along the I-70 Mountain Corridor. These alternatives consist of various forms of rubber tired, rail based, and promising new technologies for ground transportation. Each of these alternatives has a large number of type variations due to options in guideway technology, line configuration, propulsion source, and design capacity. These differences affect the initial capital costs to construct the proposed system, the unit cost of the vehicles, the number of vehicles required to meet proposed schedules, and the costs to operate and maintain the system. These option choices significantly affect the ultimate capacity of the proposed system, the overall running time between end points, the energy consumption per passenger, and the environmental impacts of the system.

PURPOSE AND SCOPE

The purpose of examining transit alternatives is to determine whether any ground transportation technologies that either currently exist or show significant promise in being developed in near future could be used to provide a meaningful component of the overall I-70 corridor capacity. All fixed guideway and rubber tired systems that provide an enclosed, lighted, and heated passenger cabins are open for consideration. The systems must also be capable of traversing the I-70 Mountain Corridor segment in less than 3 hours, which would be at a minimum average speed of approximately 35 mph.

METHODOLOGY

Attributes of existing technologies were culled from various sources within the Transportation Research Board (TRB) of the National Academy of Sciences, Jane's World Railways, Jane's Urban Transport Systems, the American Public Transportation Association (APTA), the Association of American Railroads (AAR), the Federal Transit Administration (FTA), and the Federal Railroad Administration (FRA) of the United States Department of Transportation. Attributes of promising technologies were provided by the technology proponents and in most cases have not been tested or verified under real-world operating conditions.



Technologies were divided into five exclusive groups based on general operating characteristics. These groups are:

- Busways
- Automated Guideway Transit
- Rail Transit
- Passenger Railroads
- Advanced Guideway Systems

Characteristics of each type technology are described along with various implementation options, photographs, and key points applicable to the I-70 Mountain Corridor. In a screening to be accomplished later in the PEIS, performance criteria for each system will be measured against other systems to develop a ranking of the technology among its peers for application to the I-70 Mountain Corridor. After a second screening the most viable existing technology and promising technology will be identified for further evaluation against other highway improvement options.

RESULTS AND FINDINGS

The difficult mountain terrain traversed by the I-70 Mountain Corridor limits the performance of many transit technologies. Vehicles must operate up and down 6% grades, follow tight highway curvature, operate unobtrusively in a spectacular mountain setting, fit within a narrow highway right-of-way, and not significantly degrade the environment while also providing a serious alternative to highway expansion. The route is long and mostly rural or wilderness in character, which limits typical urban solutions.

The overall operating requirements for a 35-mph average speed and an enclosed, lighted, heated cabin eliminate a number of short haul systems that would be inappropriate for a 100 mile corridor. These include escalators, moving sidewalks, funiculars, aerial tramways, bikeways, and hiking paths.

A total of 12 different technologies were found to meet the general requirements for operation in the corridor. Of them, only a few have real potential to truly provide a cost effective, environmentally friendly transit alternative. The most likely candidates will be examined further as part of the system screening process.



1.1 BUSWAYS

Options to utilize buses in the I-70 Mountain corridor consist of a number of separate configurations of infrastructure and rolling stock. In this report the term "Bus" is defined to mean any self-powered vehicle designed for commercial use and capable of operating on state roads carrying in excess of six passengers. Fuel may be diesel, gasoline, compressed natural gas (CNG), propane, or other available alternates. Buses using electric propulsion are referred to as "ETB" and hybrid buses using both electric propulsion and self-generated power are referred to as "HEB".

Operation in Mixed Traffic means the bus is commingled with regular traffic on I-70. High Occupancy Vehicle (HOV) lanes refer to special traffic lanes that are intended for buses, car pools, and any vehicle carrying a minimum number of passengers set by the HOV operator (usually 2 or 3). HOV lanes may be either a regular highway lane distinguished with specially painted lines, symbols, and signage or a segregated roadway with its own access ramps. A Transitway is a completely separate roadway limited to transit vehicles only. It may contain special bus guide rails to reduce lane width requirements and help speed operations.

Each of the 5 scenarios that follow have significantly differing capital costs, operating costs, running times, and capacity limitations. Examples of each of these systems are currently available and in operation somewhere in the world.



1a - Bus in Mixed Traffic

This alternative would use buses operating within the general traffic lanes of I-70 to provide additional highway traffic capacity. The additional highway capacity is obtained by using the buses as a replacement for numerous automobiles, thus freeing up lane space.

Buses could operate from pick-up/drop-off points in Denver or from specially built Park & Ride lots near the entrances to I-70. The capacity of this alternative is essentially tied to the capacity of the I-70 highway lanes. The buses would have no lane priority therefore speeds would be limited by traffic conditions. The buses would also operate slowly on the numerous grades on I-70 as typical available engine output limits the horsepower available.

The types of bus vehicles that could be used include standard 40-foot coaches, tractorpulled units, articulated sets, or double-deckers. Either diesel fueled or alternate fueled power plants can be utilized. Electric Trolley Buses (ETBs) can not be used due to the limited maneuverability of these types of buses alongside higher speed traffic running at the 65-MPH speed limit on I-70. Smaller buses and van operations could also be used as a supplement to the service.

This is a typical suburban or over-the-road bus operating scenario with examples available in any large metropolitan area. Some of the services described above are already being provided on a much smaller scale within the corridor.

[Insert small photos of over-the-road buses here with captions in Italics, prefer one picture each of standard, tractor-pulled, articulated, and double-deck]



[Substitute page with "Bus in Mixed Traffic" diagram here]



1b - Bus in HOV Marked Lane

This alternative would add a third lane to I-70 in each direction. The lane would be restricted to High Occupancy Vehicles (HOV) such as buses, vans, and automobiles carrying at least 3 persons. A simple paint stripe and signage would separate the HOV lane from adjacent traffic.

Bus service would operate similarly to the system described in Section 1a except that once the buses enter I-70 they would move to the inside HOV lane and travel to their destination with presumably less congestion than in the regular travel lanes. Congestion at interchanges would still be a factor, as would difficulties maintaining speed on grades. In addition, due to the existing high passenger occupancy levels per automobile on this corridor, so many vehicles would qualify for the HOV lanes that any travel advantage might be minimal. Continuous enforcement of the 3-person limit would be required and add to the operating costs of this alternative.

Body style and propulsion types described in Section 1a are also applicable to this alternative. ETBs cannot be used due to the multiple crossover movements required to access the inside HOV lane. The eastbound and westbound HOV lanes could be operated as restricted to HOV qualified traffic at all times or only in the peak direction, with the opposite direction HOV lane opened for general use.

[Insert photo of bus with automobiles operating in marked HOV lane – 3-lane configuration preferred]



[Substitute page with "Bus in Marked HOV Lane" diagram here]



1c - Bus in HOV Segregated Lanes

In this option, the HOV lanes would be built as a separate highway facility, either in the median of I-70 or as a parallel roadway. A median barrier would completely separate this facility from the general highway lanes. Bus body style and propulsion types described in Section 1a are applicable to this alternative. ETBs and HEBs could be used due to the separate interchanges, but high speed running in mixed traffic has not been tested for this option. The appearance of the overhead wires would be a problem.

The segregated lanes require less HOV enforcement effort and are less affected by adjacent lane traffic problems. Diesel buses would operate slowly on the grades as engine output limits the horsepower available

Bus service would operate similarly to the system described in Section 1a except that the buses would enter and leave the HOV lanes at special interchanges. They would travel to their destination with presumably less congestion than in the regular travel lanes. Congestion at regular interchanges would not be a factor, but difficulties maintaining speed on grades would still be a problem. As in Section 1b, due to the existing high passenger occupancy levels per automobile on this corridor, so many vehicles would qualify for the HOV lanes that any travel advantage might be minimal. Enforcement of the 3-person limit would still be required (but at a significantly less level due to the restricted entry points) and will add to the operating costs of this alternative.

A single pair of HOV lanes can be set to operate only in the peak direction as dictated by demand. This option requires considerable daily maintenance to clear and reverse the lanes, but keeps highway right-of-way use to a minimum. This scenario would require HEBs to return in mixed in traffic, without the electric power advantage on the grades. ETBs could not be used for the return in mixed traffic.

[Insert photo of bus with automobiles operating in segregated HOV lane – Shirley Highway (I-395) in Northern Virginia a good example]



[Substitute page with "Bus in Segregated HOV Lane" diagram here]



1d - Bus in Separate Transitway

In this option, a separate roadway dedicated just to buses would be constructed in the median of I-70 or as a parallel roadway. With only professionally operated buses traveling at the same speed, only one lane with a shoulder is required. Enforcement would be minimal as Automatic Vehicle Identification (AVI) technology could be used to raise a barrier at the transitway entrances.

Bus service would operate similarly to the system described in Section 1a except that the buses would enter and leave the transitway at special interchanges. They would travel to their destination with virtually no congestion. For diesel buses, difficulties maintaining speed on grades would still be a problem. Operation of ETBs and HEBs under electric power would be possible and their use would eliminate any slow operation on grades. The appearance of the overhead wires would be a problem.

A single direction transitway could be set to operate in the peak direction as dictated by demand. This option keeps highway right-of-way use to a minimum. This scenario would require HEBs to return in mixed in traffic, without the electric power advantage on the grades. ETBs could not be used for the return in mixed traffic.

A separate transitway can also be operated like a rail rapid transit system, using stations along the transitway for passenger boarding instead of leaving the transitway and circulating into the community. This scenario is known as Bus Rapid Transit (BRT) and will be an option to be reviewed under the screening.

[Insert photo of bus operating in separate transitway – Ottawa or Pittsburgh would be good examples, also BRT station photo would be useful]



[Substitute page with "Bus in Separate Transitway" diagram here]



1e - Bus in Guided Transitway

In this option, a separate roadway dedicated just to special buses with guideway attachments would be constructed in the median of I-70 or as a parallel roadway. With only professionally operated buses traveling at the same speed, only one narrow guideway lane is required for each direction. No enforcement costs would be required, as conventional vehicles could not use the guideway.

Bus service would operate similarly to the system described in Section 1a except that the buses would enter and leave the guided transitway at special interchanges. They would travel to their destination with virtually no congestion. For diesel buses, difficulties maintaining speed on grades would still be a problem. Operation of ETBs and HEBs under electric power would be possible and their use would eliminate any slow operation on grades. Due to the presence of the guideway, 3rd rail power pickup for ETBs and HEBs could be used in place of overhead wires.

A single direction guided transitway could be set to operate in the peak direction as dictated by demand. This option keeps highway right-of-way use to a minimum. This scenario would require HEBs to return in mixed in traffic, without the electric power advantage on the grades. ETBs could not be used for the return in mixed traffic.

A guided transitway can also be operated like a rail rapid transit system, using stations along the transitway for passenger boarding instead of having buses leave the transitway and circulating into the community. This scenario is known as Bus Rapid Transit (BRT) and will be an option to be reviewed under the screening phase.

[Insert photo of bus operating in guided transitway – sent previously, more can be found in Australia]



[Substitute page with "Bus in Guided Transitway" diagram here]



Summary of Busway Options

Buses operating in mixed traffic, as they do today, have little potential for relieving congestion on the I-70 Mountain Corridor.

In a corridor with already high passenger/vehicle averages, HOV lanes are bound to be congested shortly after their opening and will require continuous enforcement to keep them from reverting to general lane status.

Conventional buses operating on transitways are limited by the grades in this corridor and will produce unacceptable slow speeds, limiting ridership.

All electric buses cannot efficiently serve areas outside the corridor due to the lack of the overhead wire infrastructure in origin and destination areas.

Hybrid electric buses allow for fast mountain operations and flexible service areas outside the corridor. When operated on a conventional transitway, they would require unsightly overhead wires and that would be a significant visual obstacle to overcome.

Hybrid electric buses when operated on a guided transitway can draw power from an unobtrusive third rail in the guideway and operate normally outside of the corridor. The guideway would also be very narrow and presents the most effective use of the existing right-of-way.



2 - AUTOMATED GUIDEWAY TRANSIT

These systems have the common characteristic that they provide service without a human operator. Their guideway therefore must be completely protected to ensure that the automated vehicles cannot contact people, automobiles, or other obstacles in the guideway. For this reason they generally operate only short distances and stay within the definition of an "urban" system. The Federal Railroad Administration (FRA) does not regulate them. They can be operated using conventional rail transit steel wheel vehicles, rubber tires with a guide mechanism, or on a monorail. They are usually differentiated five ways: (1) Where they operate, (2) Whether they can operate outside, (3) Whether they operate with more than one independent vehicle per guideway, (4) Whether they can operate multiple routes, and (5) The propulsion mode of the vehicle.

Automated Guideway Transit systems in airports are often referred to as APM (Airport People Mover) Systems. Automated Guideway Transit systems used for downtown circulation are often referred to as DPM (Downtown People Mover) systems. DPM systems are currently operating in Detroit, MI and Jacksonville, FL. Automated Guideway Transit used in universities (Morgantown), hospital campuses (Duke), amusement parks, and other institutions are usually referred to as either a people mover or by the technology used (i.e.: the monorail, the tram, the shuttle). Automated Guideway Transit systems used for general circulation in an urban area are called ICTS for Intermediate Capacity Transit System. Only one example of this technology exists as an automated operation not exclusively in a downtown area and that is in Vancouver, BC.

Many Automated Guideway Transit systems are operated totally indoors through corridors in buildings. These systems, often found in airports, have far less difficulty providing a safe operating guideway than those operating outside. In two cases the vehicles used in these indoor systems don't even have ceilings, with lighting provided on the roof of the tunnel. They are located in Houston Intercontinental Airport and the basement of the United States Capitol.

The complexity of Automated Guideway Transit increases substantially when more than one vehicle can operate on the same guideway. Simple cable hauled systems handling only one vehicle per guideway can be operated using common elevator technology. When more than one vehicle is on the guideway, a sophisticated signal system is necessary to provide safe separation between the vehicles and to control braking and acceleration. Obviously, systems that can operate multiple vehicles on a single guideway are more efficient and have a much greater capacity.



Some Automated Guideway Transit systems have the ability to operate on multiple routes on either a preprogrammed schedule or on a demand basis determined by the rider. Preprogrammed systems are referred to as GRT (Group Rapid Transit). Rider demand systems as referred to as PRT (Personal Rapid Transit). Only one true PRT system is in operation at this time. It is an experimental system built in 1974 in Morgantown, West Virginia. It provides service to a large university campus and connects it to downtown Morgantown. Riders select their destination like floors on an elevator. Each small car carries the rider and accompanying parties directly to the station desired, bypassing any other station along the way.

Automated Guideway Transit can be powered by electric traction, cable hauled, or utilize linear induction motors. Sometimes Automated Guideway Systems are characterized by their vehicle capacity. Small systems can be referred to (inaccurately) as PRT systems, larger vehicles as GRT systems, and full size subway-like vehicles as ICTS.

When evaluating transportation options for a long corridor, only those systems that can operate outside, with multiple vehicles per guideway, need be considered. The ability to operate on multiple routes or the capacity of the vehicle is a variable that would depend on demand forecasts and the overall corridor development plan. The choice of propulsion is currently limited to electric traction and linear induction motors. The choice of guideway is either conventional rail, concrete guideway, or monorail.

No Automated Guideway Transit system in use operates over a corridor as long as the I-70 Mountain Corridor. Use of this technology would be controversial since no experience is available for operations in a long, remote corridor. The FRA does not currently regulate these systems since they are considered "urban" systems. Implementation on the I-70 Mountain Corridor would most likely trigger a review of the scope of current regulations, with unpredictable results. The lack of an operator to handle breakdowns or emergencies in remote areas would appear to eliminate this technology from consideration.



2a - AGT using Conventional Rail

This type of system is currently in operation in Vancouver, BC Canada. A manned version is also in operation in suburban Toronto, ON Canada. The linear induction motors in use allow quick acceleration, but can be noisy.





2b - AGT using Monorail

This type of system is currently in operation at Downtown Jacksonville, FL and the Newark, NJ Airport.





3 - RAIL TRANSIT

Options to utilize rail transit in the I-70 Mountain corridor consist of either light rail or heavy rail transit systems. Each type of system can be constructed as a double-track line or as a single-track line with passing sidings. Either electric or diesel propulsion systems are available. The tracks can be located in the median of I-70 or on a parallel alignment, diverging only for heavy grades and to serve off line stations. In this report the term "Rail Transit" is defined to mean any conventional rail vehicle designed to operate on tracks not connected to the national railroad network. These systems, when operated in an "urban" area, are exempt from Federal Railroad Administration (FRA) regulation.

Rail Transit vehicles may self-generate their own power or utilize electric propulsion. The term "DMU" refers to light rail Diesel Multiple Unit vehicles that can be operated on non-electrified lines that are not regulated by the FRA. Generally, Light Rail Transit (LRT) and Heavy Rail Transit (HRT) systems utilize electric propulsion. LRT vehicles can, if necessary, operate on tracks in city streets with motor vehicle traffic. Light rail trains could also operate in mixed traffic through the Eisenhower Tunnel to avoid separate transit tunnel costs.

High capacity HRT systems must operate only on exclusive rights-of-way due to their large vehicle size, long train lengths, their inability to brake and accelerate within motor vehicle tolerances, and (often) the presence of a ground mounted electric third (power) rail. They do have many more options for power pick-up and automation than LRT systems but represent one of the highest costs per mile to construct.

The use of Rail Transit vehicles on the I-70 Mountain corridor would be controversial since Rail Transit systems are designed for urban and metropolitan areas and are not currently operated in North America on lines as long and remote as this corridor. Although "Interurban" systems utilizing basic Rail Transit technology frequently operated for hundreds of miles in the first half of the 20th Century, there are no surviving examples in service today (the oft-cited South Shore line in Chicago was built as an Interurban but is currently operated as a FRA compliant railroad). Although examples of long distance rail transit systems can be found in Europe, none are compliant with FRA vehicle safety requirements. The use of this type of equipment would depend on whether the FRA considers the system "urban" or if a difficult-to-justify safety waiver could be obtained.



3a – Light Rail Transit

This type of rail transit system is designed for medium capacity urban and suburban transportation. It differs from Heavy Rail Transit by its ability to operate in mixed street traffic if desired. These vehicles meet all highway operating standards for braking, acceleration, directional turn signals, and sight distances from the operators position. Usually, though, these systems are operated on either a reserved roadway median or an exclusive right-of-way. Their flexibility to operate in many environments and lower initial costs than Heavy Rail Transit has made them the fastest growing rail transit mode in the nation, with over ten new systems being opened in the last twenty years.

Although typically operated using a 600V-700V DC overhead wire, diesel propulsion and 3rd rail versions are also available. Vehicles can utilize low level or high level boarding platforms and are ADA accessible. Newer low-floor versions are also available to speed street level boarding. Vehicles are available from many suppliers.

Light Rail Transit cars are usually 75 – 90 feet long and often operate in train lengths of one to five cars. Train length is typically limited by the street block size when operating in mixed traffic, to avoid blocking intersections. The vehicle width is smaller than Passenger Railroad systems (typically 8.5 feet) to be able to operate on roadways.





3b – Heavy Rail Transit

This type of rail transit system is designed for high capacity urban and suburban transportation. It differs from Light Rail Transit by its requirement for an exclusive right-of-way. These trains are too big and long to operate on highways and the operator cannot see nor brake sufficiently to deal with typical highway maneuvers. Heavy Rail Transit vehicles are capable of high acceleration and are one of the few modes in this report with sufficient power to operate over the I-70 grades at full speed. The PATCO system in Philadelphia currently operates over a 6% gradient on either side of the Ben Franklin Bridge. The BART system in San Francisco uses high performance motors that will out-accelerate an automobile with a ten-car train.

Although typically operated using a 600V-700V DC 3rd rail, diesel propulsion and overhead catenary versions are also available. Vehicles utilize high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Vehicles are available from many suppliers.

Heavy Rail Transit cars are usually 70 - 90 feet long and often operate in train lengths of two to twelve cars. The vehicle width is sometimes smaller than Passenger Railroad systems but cars can be built to their standards if desired





4 - PASSENGER RAILROADS

Options to utilize Passenger Railroads in the I-70 Mountain corridor consist of two separate configurations. In this report the term "Passenger Railroads" is defined to mean any conventional rail vehicle operating on track connected to the national railroad network. These systems are regulated by the Federal Railroad Administration (FRA).

Passenger Rail trains operate throughout the United States. All of these systems share many similarities since they must comply with various construction standards and operating regulations promulgated by the FRA. When operated between a major city and its suburbs the service is referred to as "Commuter Rail." When operated between major cities the service is referred to "Intercity Rail." Virtually all intercity trains in the United States are operated by Amtrak.

Intercity trains are further subdivided into Short Haul and Long Haul service. Short Haul trains are almost always day trains operating between cities less than 500 miles apart. Long Haul trains operate overnight and many travel across the entire country. Equipment configuration differs between Commuter Rail, Short Haul Intercity trains, and Long Haul Intercity trains. Commuter Rail trains have fairly constricted seating designed for short trips. Short Haul Intercity trains are more generous with seating space and usually provide food service. Long Haul Intercity trains provide seating with leg rests and deep reclines for overnight trips as well as full dining car service, lounge cars, and sleeping room cars.

A variant of Short Haul Intercity train service is High Speed Rail. These trains operate at very high speeds (over 125 mph) for premium fares. Only one system currently exists in the United States. It is currently in service in between Washington, New York, and (soon) Boston. Dozens of other states as also planning High Speed Rail systems, with California and the Midwest (centered on Chicago) in the most advanced state. High Speed Rail systems require a straight, flat trackbed to achieve their speed goals and attendant ride quality.

Passenger Rail trains may be hauled by diesel locomotives or electric locomotives. The trains may also be made up of multiple unit cars, each with their own diesel or electric traction motor(s). Electric power can be delivered through overhead catenary wires or a third (power) rail. Conventional railroad trains are limited to a maximum gradient of about 6%, although they are usually designed to operate with only a maximum of a 2% grade on most mainlines, with some exceptions. These systems are very flexible, as they are able to operate on both new alignments as well as existing trackage shared with freight trains.



4a - Locomotive Hauled Trains

This option would provide rail service using existing trackage from Denver Union Terminal to Golden and then over a new alignment to the I-70 corridor. The new tracks would run parallel to I-70 to Dotsero and then rejoin existing trackage that leads to Glenwood Springs and Grand Junction. The grades on this line would require use of a number of diesel locomotives to power each train in order to be able to traverse the grades in a reasonable period of time.

Electric locomotives could also be utilized to mitigate the grade problem and help maintain air quality standards. Overhead catenary would be necessary but could be designed to minimize visual impacts. 3rd rail systems could also be utilized but would require a completely separate, fenced right-of-way to avoid any dangers to trespassers and wildlife (although underrunning type 3rd rail is far less accessible than the exposed overrunning type. Due to the distance, 25,000V AC overhead wire systems are the most efficient. 600-700V DC 3rd rail systems could also be used with frequent substations necessary along with a continuous high voltage feeder system.

Passenger Rail trains can utilize either low level or high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Locomotives and cars are available from many suppliers.

Passenger Rail train cars are 85 feet long, 10.5 feet wide and can be operated in trains as long as 20 cars. Cars can either be single deck (13.5 feet high) or double deck (16.2 feet high)

[Insert Amtrak train photos here – one single level, one double level]



4b – Multiple Unit Trains

This option would provide rail service using existing trackage from Denver Union Terminal to Golden and then over a new alignment to the I-70 corridor. The new tracks would run parallel to I-70 to Dotsero and then rejoin existing trackage that leads to Glenwood Springs and Grand Junction.

Diesel powered and electric powered multiple unit trains could be used to provide service along this line. Multiple unit trains have a power advantage in that every car has its own driving motors. Overhead catenary would be necessary but could be designed to minimize visual impacts. 3rd rail systems could also be utilized but would require a completely separate, fenced right-of-way to avoid any dangers to trespassers and wildlife (although underrunning type 3rd rail is far less accessible than the exposed overrunning type). Due to the distance, 25,000V AC overhead wire systems are the most efficient. 600-700V DC 3rd rail systems could also be used with frequent substations necessary along with a continuous high voltage feeder system.

Passenger Rail multiple unit trains can utilize either low level or high level boarding platforms and are ADA accessible. Stations are required for boarding and alighting. Multiple unit cars are available from many suppliers.

Passenger Rail multiple unit train cars are 85 feet long, 10.5 feet wide and can be operated in trains as long as 20 cars. Cars can either be single deck (13.5 feet high) or double deck (16.2 feet high)



5 – ADVANCED GUIDEWAY SYSTEMS



For the over hundred years there have been only two realistic modes in use for ground transportation: railway and highway. In the last twenty years research has been closing in on two types of magnetic levitation (maglev) systems that can be used for a new generation of high speed ground transportation. In addition, an older mode primarily used for transit applications, the monorail, has been proposed in various forms for higher speed intercity service.

These systems share a common attribute. None has been operated in revenue service over a line anywhere near this length. Implementation would require a significant construction cost risk, performance risk, and operating cost risk. Costly development and testing would be necessary to even prove the concept and develop the design to meet current safety requirements.

While a successful implementation of this technology would certainly be a major victory for these technology proponents, the costs and returns to the taxpayers would be questionable if other proven technology were able to meet the needs of the travelling public, most of whom don't care how the vehicle is propelled.

The major advantage of both the maglev and monorail technologies is speed. Running times could be significantly shortened, but the infrastructure necessary to accomplish this time savings may mean significant new right-of-way acquisition. Curve limitations will limit the use of the I-70 corridor for most high speed conventional rail, monorail, or maglev systems



5a - Monorail Systems

The monorail concept utilizes a single elevated beam to carry a train over any ground based obstructions. Vehicles can ride above the beam, hang from the beam, or run astride of the beam. The concept has been in operation since the 1950s in amusement parks, downtown circulators, and airport AGT systems. In Japan, some monorail systems are used between downtown areas and airports.

Monorails are operated essentially as Heavy Rail Transit since they are grade separated and cannot run in mixed traffic. They have most of the attributes and limitations of Heavy Rail Transit, but have not been proven in a corridor as long or as remote as the I-70 Mountain Corridor.

A monorail system would need a circulation system at each end of the trip to provide reasonable access. Propulsion for the trains is electric using either conventional electric traction motors or a proposed linear induction motor system. Vehicles can be operated using rubber tires or steel wheels.





5b - Magnetic Levitation Systems

Maglev systems have been under development since the 1960s. Two types are being actively tested. A German attraction based design where the magnets on the track are attracted to electromagnets on the car, which are used to levitate the car for high speed running. Also a Japanese repulsion based design where the magnets on the track push the car away to levitate it in a trough for high speed running.

The German design, which was being planned for a new line from Berlin to Hamburg, was recently defunded. The Japanese design is still undergoing full scale testing in a section of the planned track built outside of Tokyo.

Although both systems would be capable of operating in the I-70 Mountain Corridor, neither is sufficiently advanced to generate reliable cost and performance data.





CONCLUSIONS AND RECOMMENDATIONS

The I-70 Mountain Corridor presents a number of challenges to designers of transit alternatives. The grades limit vehicle performance. The curves limit speed. The rightof-way limits the width available for infrastructure. The mountain vistas limit the choice of power systems. The remoteness limits automation solutions. A few choices do remain that show significant promise in helping alleviate congestion on the corridor.

Of the Busway options, the best appears to be use of a hybrid electric bus (similar to those currently operating in Seattle) operating over a guided transitway. A single peak lane would work, but would limit return speeds and performance. A double lane would be ideal and fit within the existing highway median in most locations along the corridor.

Of the Automated Guideway Transit options, none appears to be suitable for a long, remote corridor. The prospect of being stranded in a vehicle breakdown without even an operator on-board presents too many negative scenarios.

Of the Rail Transit options, an electric multiple unit train similar to those operated by BART in San Francisco and PATCO in New Jersey appears to have all of the necessary capabilities to operate successfully in the corridor. The looming question of FRA regulatory jurisdiction and its affect on equipment design is currently open and one of significant concern.

Of the Passenger Railroad options, the only equipment capable of operating in this corridor would be an Electric Multiple Unit train, which would have the horsepower, tractive effort, and adhesion necessary to operate at substantial speed on up to 6% grades. It also has the advantage of being able to use existing railroad connections at Dotsero and Golden to continue operations beyond the I-70 Mountain Corridor and into Denver Union Terminal.

Of the Advanced Guideway Systems, the two magnetic levitation systems require a much straighter right-of-way than is available in the I-70 Mountain Corridor without significant tunneling. The aerial monorail approaches appear feasible, but would require a significant amount of testing and certification before they could be ready for implementation. The uncertainty of the monorail's final design parameters could delay upgrade work in the I-70 corridor while waiting for the results of testing to determine such items as the location of support piers and ground based facilities.



Of the existing systems it is recommended that further analysis be undertaken on the Hybrid Electric Guided Busway using 3rd rail equipped buses, the Rail Transit alternative using 3rd rail equipped electric multiple unit vehicles, and the Passenger Railroad option using 3rd rail electric multiple unit vehicles. Of the promising systems, the monorail system should be investigated further.